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ENGINEERING

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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THE INDUSTRIAL PROGRESS OF JAPAN AND ITS PROBABLE EFFECTS.

THE European reputation of Japan rests on her war-like achievements more than on anything else, for the war with China in 1894 undoubtedly created a new factor in Far Eastern politics, and the Russian War ten years later introduced a new great Power in a military sense; but it is very doubtful whether Japan's possibilities as a great Power in an industrial sense are realised at all adequately. As an indication of what the country is capable of it will be interesting to summarise here the marvellous progress made in Japan in all branches of engineering during the last half century.

In connection with railways, the first line from Tokyo to Yokohama was started in 1869 and opened in 1872. This was followed in 1872 by the Osaka-Kôbe line. These were Government lines built by English engineers with British material. These lines continued to progress, but in order to encourage railway expansion, private railway enterprise under Government guarantee was started in 1881, and by 1899 there were in addition to the Government lines 30 private lines. In 1906 and 1907, probably as a result of better foreign credit, the Government decided on a policy of nationalisation, and bought up 17 private companies, increasing the mileage of Government lines from 1,518 miles to 4,371 miles. Since that date the mileage of Government-owned lines has increased by over 1,388 miles, so that it cannot be said that stagnation has set in, a process regarded as infallibly following Government interference in industrial concerns in some other countries. On the contrary, the following statistics show that the cost of transport in Japan has fallen considerably since the nationalisation of the railways. Thus in the case of passenger and goods traffic, this has doubled itself in the first case and quadrupled itself in the second since 1906, when the nationalisation scheme was instituted. Rates have fallen as follows:—

	Year 1906. Yen.	Year 1916. Yen.
Passenger fares, per mile ...	0·0155	0·0134
Goods rates, per ton-mile ...	0·0199	0·0166

(The yen is worth 2s. in normal times.)

In other respects also, as for instance higher average load per goods wagon and average load per train the Government control has been beneficial as the following figures show:—

Year 1906: Average load per goods wagon, 7·1 tons.
Year 1916: Average load per goods wagon, 9·8 tons.
Year 1906: Average load per train, 71 tons; number of cars, 20.
Year 1916: Average load per train, 128 tons; number of cars, 28.

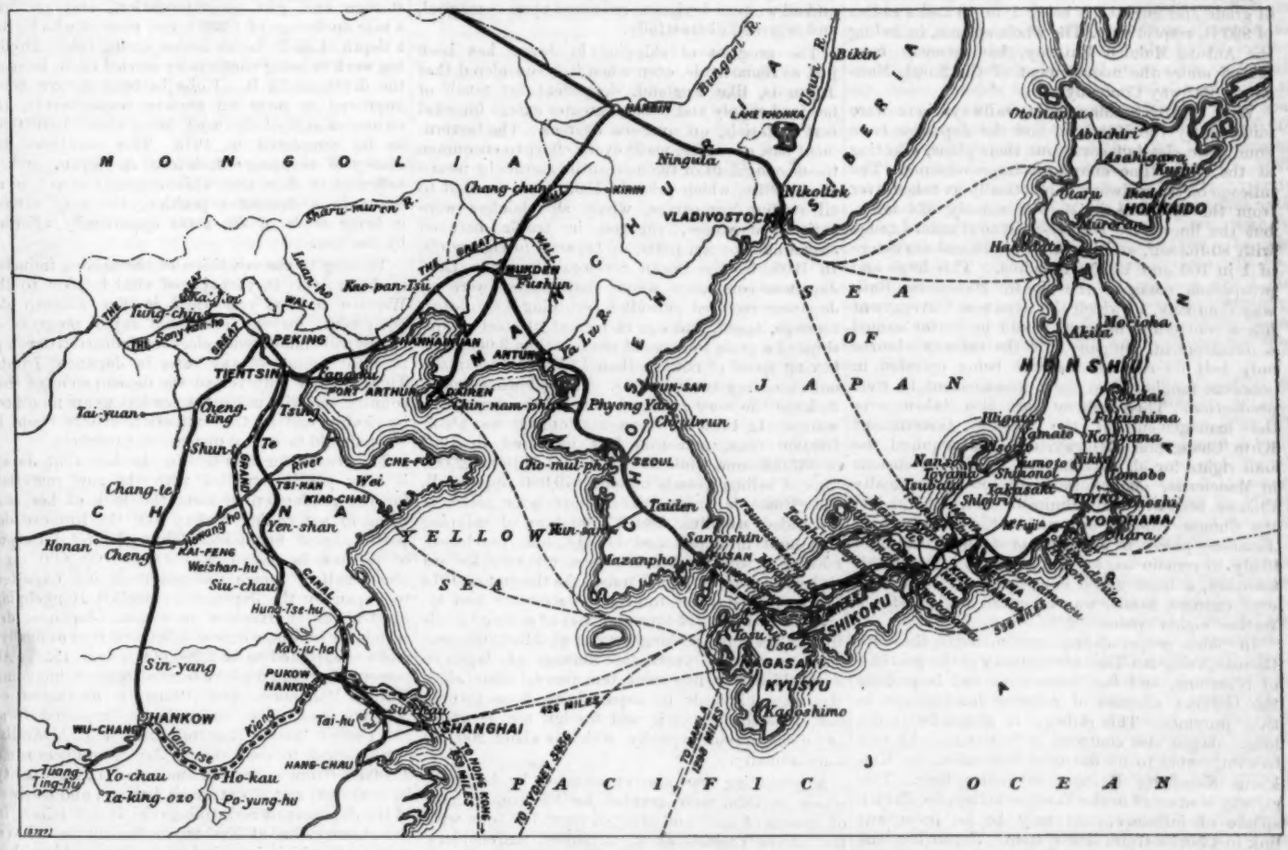
The above results are, of course, due in part to an enormously increased traffic which has been coped with by betterments in the shape of heavier rails and improved alignments, and, in many cases, additional tracks. In spite of these improvements there is still at times considerable traffic congestion and, it is said, a considerable car shortage. Out of this arises the present outcry against the 3 ft. 6 in. gauge, which is standard in Japan, and the demand for the English standard gauge, which is being seriously considered.

There are, in addition to the Government lines, eight private railways, with a mileage of 272 miles, of the standard 3 ft. 6 in. gauge, and twelve light railway companies of 2 ft. 6 in. gauge, with a mileage of 1,465 miles. Railway construction is stimulated by grants in aid and guarantee by the Government of interest up to the limit of 5 per cent. on the construction cost. The standard of construction and equipment of the standard gauge lines in Japan is high, rail weights ranging from 60 lb. to 75 lb. per yard, and maximum speeds 32 miles an hour. No expense is spared in maintenance, charges under this head amounting in 1915 to 234*l.* per mile, which is heavier than any other railway in the Far East, but Japanese lines also carry a considerably heavier traffic than most. In addition to railways, there are in Japan 71 companies or municipalities owning electric tramways with a mileage of 1,322 miles. The majority of these companies are also engaged in electric lighting schemes.

Altogether there are some 7,600 miles of railway for a population of some 55 millions and an area of 140,200 sq. miles, all of which have been created in less than fifty years. Japan has long since dispensed with foreign supervision of her railways, which are renowned for punctuality of service and cleanliness. She has also ceased to be dependent on foreign markets for railway supplies to a very large extent, except perhaps in the matter of steel, and even here the Imperial Steel Works at Wakamatsu are able to supply the normal demands of the railways in the matter of rails and rolled sections. The Japanese railway-workshops are the most up-to-date in the Far East. It should be said here that railway construction in Japan is hampered by great natural difficulties, the Government owned lines prior to nationalisation costing about 11,000*l.* per mile.

The above considerable achievement only represents a part of the Japanese railway effort, for she owns and manages a further 2,400 miles in her dependencies and concessions in China. These dependencies are as follows: Korea, with a population of over 13 millions of which 147,000 are Japanese, the southern half of the island of Saghalin, called Karafuto by the Japanese, which was acquired as the result of the Russian War in 1904, the Island of Formosa taken in the Chinese War of 1894, and the leased territory in Manchuria known as the Kwantung Peninsula, which was also taken over from Russia in 1904–5.

The railway history of Korea began with an American concession granted in 1896, which was bought up by a Japanese company in the following year. Private railway companies continued building slowly up to the outbreak of the Russian War, when there was a rush of very hurried railway construction under the military authorities. The lines built then were the standard gauge lines connecting the port of Antung on the Manchurian



border with Seoul the capital, and a 2 ft. 6 in. gauge line connecting the same port with Mukden the capital of Manchuria. This last was actually used in the war, but the first was not opened until March, 1906, and not for general traffic until 1908. In 1906 the policy of nationalisation of railways was extended to Korea, and all the private lines bought up. After this the port of Antung was quickly connected up with the port of Fusan* which is only 11 hours by sea from Japan. In addition, most of the lines were re-constructed, the Antung-Mukden Railway re-built to standard gauge, and the connecting link, the great railway bridge over the Yalu River, between Manchuria and Korea, completed. Thus Japanese interests in Manchuria were linked up with Japan by a route giving the shortest possible sea journey. At present the mileage of Korean railways is 1,092 miles. The lines are built to first-class standards, the rails being from 60 lb. to 75 lb. in weight, and the limits of grade and curvature being 1 in 40 and a radius of 990 ft. respectively. The whole system, including the Antung-Mukden Railway, has recently been placed under the management of the South Manchuria Railway Company.

With regard to Manchuria, railways here were initiated by the Russians, and the Japanese have done little else but carry out their plans, effecting at the same time enormous improvements. The mileage of the railways is practically as taken over from the Russians in 1904–5, namely 524 miles, but the lines have been re-built to standard gauge with 80-lb. rail, and limits of grade and curvature of 1 in 100 and 1,320 ft. radius. This huge and prosperous concern, the South Manchuria Railway Company, in which the Japanese Government has a controlling interest, would be better named a development company, for the railway absorbs only half its capital, the rest being invested in concerns ranging from hotel management to steel production. This railway has also taken over the management of the Chinese Government Kirin Changchun Railway, and has acquired the loan rights for all Government railway extensions in Manchuria. Manchuria is, of course, nominally Chinese territory and administered from Mukden, the Chinese capital, but within the railway zone Japanese power is as absolute as in Korea and likely to remain so, for the so-called lease of this territory, a lease which is no lease, for no money ever changes hands, was extended in 1915 for a further eighty years.

In China proper Japan now manages the once German Tsing-tau-Tsinanfu Railway in the province of Shantung, and has taken over and is pushing the German schemes of railway development in that province. This railway is about 280 miles long. Japan also controls, in fact it may be said to own, owing to its financial difficulties, the Kui-kiang Nanchang Railway 80 miles long. This railway is situated in the Yangtse Valley, the British sphere of influence, and may be an important link in China's trunk line system. Japan has lent 240,000*l.* on this line with the right to take over the management if interest is not forthcoming, and there is every possibility of this occurring, as this is a private railway without Government backing.

Japanese interest in railway loans in China is as follows :—

Date of Loan.	Railway.	Duration.	Issue Price.	Amount.	Interest
				£	p.c.
1909	Part of Peking-Mukden Railway east of Liao River	18	93·0	32,000	5
1909	Kirin-Changchun ..	23	93·0	215,000	5
1910	Peking-Hankow Railway	10	97·50	220,000	7
1911	,, ,,	25	96·0	1,000,000	5
1917	Kuikiang - Nanchang Railway	—	—	230,000	—
1918	Shihpingkai Railway ..	1	—	260,000	7
	The above is a branch of the South Manchuria Railway, 55 miles long.				
1918	Kuikiang Nanchang ..	—	—	10,000	—
1918	Kirin-Huaning Railway	40	—	2,000,000	5

The Kirin-Huaning Railway is a scheme for the extension of the present Kirin-Changchun Railway to the Korean border to link up with the Japanese system.

* See map on page 229.

Thus, so far as is known, Japan is interested to the extent of nearly 4,000,000*l.* in China's railways, but there may be other loans on railway security, such as the much-rumoured loan, for which the surplus funds of the Peking-Mukden Railway are said to have been mortgaged. This is, of course, the premier British-managed line in China, on which British money to the extent of 2,300,000*l.* is invested. In addition, Japan is probably largely interested in what little railway work has been done in the province of Fukien. Lastly, Japan owns in the island of Formosa some 200 miles of 3 ft. 6 in. gauge lines which connect the north and south of the island.

It is thus seen that Japan has a railway system of about 10,000 miles, which is soundly constructed, and very efficiently managed entirely without foreign supervision. The creation of this is no inconsiderable achievement when it is considered that fifty years ago, railways, the electric telegraph, and all western devices were looked upon as magical, and regarded distrustfully.

The progress of shipping in Japan has been just as remarkable, even when it is considered that Japan is, like England, dependent for much of her food supply and to a far greater extent for vital raw materials, on over-sea sources. The Government has, of course, made every effort to encourage the development of the mercantile marine by means of subsidies, which prior to 1909, were granted to all trading companies, whose shareholders were entirely Japanese, engaged in traffic between Japan and foreign ports, or between foreign ports. In 1909, by the Ocean Service Subvention Law, Japanese companies whose shareholders were all Japanese received subsidies according to mileage, tonnage, speed, and age in respect of steel steamships of a gross tonnage of not less than 3,000 tons, having speed of not less than 12 knots, and an age not exceeding twelve years. The following figures indicate the very rapid advance of the mercantile marine: In 1894 the steamship tonnage was about 160,000 tons, and this had increased in 1903 to 657,000 tons, while there were in addition 322,000 tons of sailing vessels making 979,000 tons in all. The Russo-Japanese War a year later acted as an added stimulus, and 27,000 tons of shipping was built in Japan and 117,000 tons purchased, making a total of 790,000 tons, allowing for sea and war losses of 71,000 tons. At the end of 1914 the registered gross tonnage of steamers had increased to 1,577,244 tons and that of sailing vessels to 513,244 tons, making a total of 2,090,269 tons. Thus in twenty years the tonnage of Japanese steamships has increased ten times, while since the war shipyards in Japan have been turning out ships for domestic and foreign use at about twice the normal capacity, which is about 200,000 tons annually.

Shipbuilding was also encouraged by bounties, which in 1896 were granted for the construction of vessels of iron and steel of over 700 tons with the above proviso as to Japanese shareholders. Prior to this date it was customary to order all vessels of over 1,000 tons from abroad. In 1909 vessels in order to earn bounty had to be of not less than 1,000 gross tons. As far as output is concerned the bounty system has undoubtedly answered, for in 1914 428,832 tons of shipping was built in Japan, the product of 244 private shipyards. There were in addition 63 dry-docks in Japan, while Japanese salvage companies do most of the wreck work in the East. With regard to personnel, in the early days as in the railways foreigners were very largely employed both as officers in the ships and ashore in the yards, but these have been now almost entirely dispensed with. The number of shipping companies in possession of above 10,000 tons deadweight of cargo steamers, is 42, of which the two principal ones are the Nippon Yusen Kaisha, owning 50 vessels of 337,755 tons deadweight, and the Osaka Shoshen Kaisha with 42 vessels of 179,477 tons. Since the war Japanese shipping has been exceedingly prosperous as instanced by the 50 per cent. dividend paid by the Nippon Yusen Kaisha in 1918. The utmost advantage has been taken of the world shortage of tonnage, the Japanese continually starting new lines on routes previously monopolised by British or other bottoms. Thus Japanese ships are now running to India, to Europe *via* the Panama Canal as well as *via* the Cape and Mediterranean, to the Dutch East Indies and to Australia, whereas before the war their shipping activity was, with the exception of two lines to Europe and America, practically confined to their own seas. In addition to the above they were able to supply to the Allies for transport of troops from the United States 100,000 tons of shipping in 1917, and this aid was to be increased by a further 150,000 tons in each of the years 1918 and 1919. Payment for this shipping is being made in steel supplied from America.

With regard to harbour accommodation, Japan possesses 37 open ports, but the bulk of the trade is carried on through the ports of Yokohama and Kobe. The harbour of Yokohama, on which over 1,000,000*l.* has been spent, is equipped with every modern device for handling cargo, has ample storage and pier accommodation, and provides a safe anchorage of 1,230 acres, most of which gives a depth of 33 ft. below lowest spring tide. Dredging work is being continually carried on to increase the depth to 35 ft. Kobe harbour is now being improved to meet all modern requirements, the estimated cost of the work being about 1,600,000*l.* to be completed in 1919. This concludes the survey of shipping conditions in Japan, and is sufficient to show that while Japan is as yet, in no sense, in a dominant position, the very utmost is being made of the great opportunity afforded by the war.

Turning to the condition of the mining industry in Japan, this is, perhaps, of vital interest to the Western nations concerned in Far Eastern development, for the continued rapid progress of Japan will undoubtedly place the industrial development of China, at any rate, in Japanese hands. This will not only retard the development of that country, but will, unless the conditions are modified, inevitably end in the extinction of our trade in what should be one of our greatest markets.

The reason for this lies in the fact that Japan is very poorly supplied with the raw materials for the production of iron, the bulk of her coal being of non-coking variety and the iron-ore deposits almost negligible. Thus the total output of pig-iron in Japan in 1917 was 300,000 tons, about half of which was produced and exported to Japan by the Japanese controlled Hanyehping Steel-works at Hankow in China. Japanese demands for iron now exceed 1,300,000 tons annually, and are expected to be 2,000,000 tons in 1921. At present she could produce from all sources, including Korea, Manchuria and China, a maximum of 500,000 tons. The remainder is imported from the United States, England, India and Australia. With regard to coal, though Japan produces some 23,000,000 tons a year, the amount of coking quality is, as already stated, extremely limited, and the best of the Japanese-owned coking coal is not mined in the country, but at Fushun in Manchuria. Even this coal, which is suitable for gas-making, has a percentage of fixed carbon of only 50·7 per cent. against 69·36 per cent. given by the Kaiping coal of the Kailan Mining Administration which is the biggest colliery concern in China and which does a large business with Japan in coal for coking purposes.

In this way Japan is dependent for fuel and ore for the production of the most vital material, to the largest extent on the United States or other nations at least as powerful as herself. Her great anxiety to secure independent sources of supply is, therefore, not to be wondered at, and the war, combined with the mismanagement, extravagance and feebleness of the present Government of China have provided an excellent opportunity for securing this end. This opportunity has been put to such excellent use that by various means, some of them perhaps questionable, Japanese mining companies are now in possession of titles to 170,000,000 tons of iron-ore, whereas the Chinese Government itself has titles to only 100,000,000 tons. These amounts comprise all the present known workable and accessible supplies of iron-ore in China. Japan has no competitor, and has been allowed to monopolise interests which lie in spheres of interest

not her own. The following list of loans for which the industrial assets of China have been bartered go to show that the latter country is rapidly drifting into the condition of a vassal state. It will be observed that all these loans have been contracted since the war broke out :—

Date.	Amount.	Interest	Security.	Duration. Years.	Price.
	£	p.c.			
1915	500,000	6	Mining concessions in Hunan and Anhui	3	94
1916	200,000	—	Hankow paper mill ..	—	—
1916	100,000	—	Hankow Hydraulic Electric Company	—	—
1917	300,000	—	Canton cement works ..	—	—
1917	150,000	—	Shantung mining concessions	—	—
1917	8,000	—	Heng Chow, Hunan Province, Electric Light Company	—	—
1917	15,000	—	Electric Light Company in Hunan	—	—
1918	200,000	8	Printing Bureau ..	3	98
1918	100,000	—	Shares of Kailan Mining Administration	—	—
1918	200,000	7	Iron mines in Anhui and antimony mines in Hunan	5	94
1918	300,000	—	Wireless telegraph ..	—	—
1918	2,000,000	7½	Government telegraphs..	—	98½
1918	300,000	6½	Penchihu Colliery, Manchuria	—	95
1918	300,000	—	Iron mine in Kiangsi Province	—	—
1918	3,000,000	7½	Gold mines and Government forests in Korea	—	—

In addition to the above, Japan has invested in the development of the Hanyehping Steel-works, iron-mines and collieries 3,200,000*l.* between the years 1903 and 1913. This was originally the property of the Chinese Government, but is now controlled by Japan, with the result that the benefit to China is practically nil, most of the product being exported to Japan in addition to large exports of coal, amounting to as much as 270,000 tons in 1915. This is the best coking coal in China, having 88 per cent. fixed carbon. Such great importance is attached to this concern that Japan forced China in January, 1915, to agree not to confiscate it or to convert it into a State enterprise or to borrow and use foreign capital other than Japanese.

The above list of loans does not include those rumoured, such as one for 800,000*l.* secured on copper mines in Yunnan province generally recognised as the French sphere in China, nor another for an unknown amount, said to be 1,500,000*l.*, secured by the iron deposits at Fenghuangshan near Nanking generally recognised as being within the British sphere.

Of course it may be argued that the Japanese output of iron is extremely small compared with that of America and Germany which amounted to 55,000,000 tons and 38,000,000 tons in 1914, but with Japan feverishly grabbing all the iron deposits of China, Western nations and America will in time be shut out of the Chinese market and its great possibilities, for Japan with her much cheaper labour will be able to undersell and get rid of any surplus, and after the war every market will be a matter of importance. The possibility of the establishment of a British steel industry in the colony of Hongkong, eventually the only way in which we shall be able to compete in the Chinese market, should always be kept in view, and on this account no concessions to any Power allowed in the Province of Kuantung, which is said to have great possibilities both in coal and iron.

As an indication of the rise of the Japanese steel industry, it may be stated that the demand for pig-iron increased from 59,996 tons in 1903 to 224,309 tons in 1913, and to 365,000 tons last year. The biggest steel producer is, as in most Japanese industries, the Government, which owns the Government Iron Foundry at Edamitsui, which is capable of producing 350,000 tons of steel annually and has extensions planned to increase the output to 650,000 tons. The Government also operates the Kaimishi Mining Company, with a pig-iron output of 155,000 tons. There are also three other steel and iron companies in Japan with a total maximum output of about 97,000 tons. Several works in Japan are now producing steel castings, tubes and special steels, large use being made of electric furnaces.

With regard to the production of steel and iron in Japanese dependencies, in Korea there is one coal and iron field which is being opened up by the Japanese near Seoul the capital, but as the ore deposits will only last ten years and the coal is non-coking, this will only afford temporary relief, and that only at the rate of 100,000 tons of pig-iron per year. Japan's hopes are now centred in Manchuria, where the South Manchuria Railway Company, which is to all intents and purposes the Government, is making great efforts to develop a steel industry. At Pen Chihu, on the Mukden-Antung Railway, there is a good supply of coking coal, and said to be an unlimited supply of 30 per cent. to 40 per cent. ore, with a limited amount of 70 per cent. ore, while limestone is handy. This field has been opened up by a Sino-Japanese Company, and now has two blast furnaces in operation with an output of 260 tons daily. Great efforts are also being made to develop the iron deposit at Anshanchan, about 59 miles from the port of Yingkow, and this has now an annual output of about 150,000 tons, all of which, as in the case of the Penchihu concern, goes to Japan. Coal for coking purposes for the Anshan works above comes from the Fushun mine, the property of the South Manchuria Railway. This colliery is equipped with every modern device, largely with English mining machinery, and from a daily output of 360 tons when taken over from Russia has become the second largest colliery concern in the Far East, with an output of 8,500 tons daily. It is equipped with a coke oven and by-product plant, and is also engaged in the manufacture of sulphuric acid and sulphate of ammonia, and the refinement of zinc.

Turning to China, with the exception of the Hanyehping concern at Hankow, Japanese schemes so far have not progressed beyond the agreement stage, a considerable step, but, if the experience of other non-Japanese mining concessions is anything to go by, only the beginning of considerable trouble. The present output of pig-iron at Hankow is 300 tons per day, and the amount of 63 per cent. ore mined per day is 1,800 tons, of which more than half goes to Japan, in addition to 200 tons of the daily output of pig-iron. The iron ore exported to Japan is credited to the Japanese loan and paid for in this way. Under the Japanese re-organisation scheme it is expected that the production of pig-iron will increase to 400,000 tons annually and the production of ore to 1,500,000 tons.

Apart from coal and iron, Japan is better endowed with the minerals necessary for war, and this has stimulated enormously the production of copper, zinc, lead and antimony, but even here, with the exception of copper, large imports of ore have been made, though Japan is perhaps capable of producing her own normal requirements. The money value of metals produced in Japan in 1915–6 was approximately as follows :—

	£
Gold	2,100,000
Silver	700,000
Copper	10,000,000
Zinc	700,000
Antimony	900,000
Iron	5,500,000

With regard to copper, the output increased 20 per cent, in 1916, while the price increased 55 per cent. The cost of production in Japan is about 45*l.* per ton, while the price is over 100*l.* per ton. Japan is now doing a considerable business in copper for electrical purposes. Copper is the only metal in which Japan is rich.

Japan in 1915 produced 70,000 tons of zinc, ranking next to the United States in production. Her output in 1916 was 86,000 tons, and is expected to be shortly 120,000 tons of which only half is produced from Japanese ores the balance being imported from Australia and a little from China. Japan is now producing electrically pure zinc, and is making large use of electricity for its production.

A high degree of efficiency has also been developed in the refinement of antimony—but here again Japan is absolutely dependent on foreign supplies, chiefly China, for the supply of ore.

The iron situation has been dealt with, but it should be said that in 1915 excess iron to the value of 700,000*l.* was exported, whereas in normal times Japan's needs of this from abroad were valued at 5,000,000*l.*

The war has also greatly increased the production of lead, of which Japan has some native supply. The pre-war production was about 20,000 tons annually. In 1916 the amount of lead-ore imported was about 40,000 ton, home sources of supply excluded.

In the mining industry generally the utmost use is being made of electrical methods for smelting and refining, and great attention paid to the development of the water-power of the country. Generally every effort is made to get that which is most up-to-date, even if of foreign origin. The same feverish activity pervades other industries in Japan, but is perhaps most marked in electrical and chemical industries, which the shipping shortage has stimulated.

Thus in the manufacture of electrical machinery, Japan's pre-war share of the Far Eastern trade was practically negligible, German, British and American firms monopolising the whole. But since the war Japan has found an extensive market for electric lamps, cables, and minor fittings, switches, wires, &c. In addition, Japan has lately turned her attention to the manufacture of electrical machinery of all sorts, from dynamos and motors to telephones, and as the list of loans to China for which electrical enterprises are security shows, intends to keep the market open after the war. Among the more important of these loans may be mentioned the Telegraph Loan for 2,000,000*l.* by which Japan acquired the right to finance and build with Japanese material and technical advice various undefined extensions. It is further specified that Japanese financiers are to have the first option on any future telegraph loan. Thus with the Wireless Telegraph Loan for 300,000*l.*, the whole of China's telegraphic communications will be in Japanese hands. The telegraph loan was a most immoral proceeding, as there was no intention of extending the telegraphs, the loan being merely used to finance the war between North and South China.

Japan's export trade to China in electrical supplies has increased from about 56,000*l.* in 1912 to 156,000*l.* in 1915, and in the same year other countries were supplied to the extent of a further 50,000*l.*, and these figures are on the increase. For the same two years, 1912 and 1915, imports of electrical goods fell from 1,674,000*l.* to 518,000*l.* In 1916 electrical supplies to the value of 3,606,000*l.* were manufactured. As an indication of the development of electricity, it may be mentioned that there are now 1,321 miles of electric tramway in Japan, fifty electro-chemical works whose output is valued at 5,600,000*l.* annually, and 687 power companies. The telephones and telegraphs, including wireless, are Government property, and there are 6,000 telegraph stations, and about 4,200 telephone exchanges. When it is considered that the history of applied electricity in the country began in 1871 with the introduction of the telegraph, that electric lighting was first introduced in 1886, and the first telephones in 1891, some idea is given of the progress made.

The war history of the chemical industries is similar to those previously reviewed. Thus in 1913 the excess of chemical imports over exports amounted to 7,900,000*l.*, and this fell in 1916 to 600,000*l.*, due to a vastly increased domestic output. The chemical products whose manufacture has been specially stimulated are cement, plate-glass, electrolytic caustic soda, potassium chlorate, oil and fat industries, dyestuffs, paper, sugar refining, and beer brewing. Of these industries those specially affecting British markets are cement, oils and fats, and sugar refining.

With regard to cement manufacture, the manufacturers in 1915 numbered 20 with an output valued at 1,206,000*l.* The development of the export trade is sufficiently indicated when it is considered that exports in 1913 amounted to 65,000*l.*, while in 1916 they had increased to 271,000*l.* This trade, of course, competes with the British Green Island Cement Company of Hongkong.

Further in oil and fat industries Japan is now producing the cheaper paints, has a large soap industry competing with Lever Brothers Japanese factory, is now producing glycerine and has developed a trade in lubricating oils. Japan also now exports a considerable quantity of kerosine oil to China,

thus competing with the British Asiatic Petroleum Company.

The encouragement of the sugar-refining industry has been the Government's special care, and Japan is now not only exporting to China, but has started in Manchuria, under the auspices of the South Manchuria Railway Company, the manufacture of beet sugar, coupled with a refining business. So far beet sugar is not very popular, but is being mixed with cane for retail purposes, and every effort made to encourage the growth of beet. This industry, of course, competed with the British-owned Hongkong sugar industry. In China the sale of Japanese sugar is pushed by the most unscrupulous methods.

Lastly, Japan has lately appeared as a competitor in the rubber market in China, competing with the British manufacturer in the Federated Malay States and with the Dunlop Rubber Company, who own a factory in Japan.

With regard to the manufacture of machine tools and machinery, nothing was done in the export trade before the war, and there was a large import business. The war has had the effect of creating both industries, and Japanese machine tool firms are now even manufacturing for British machine tool firms.

From the above summary of the industrial position it is easy to see that Japan must be reckoned with in future in Far Eastern markets, and that the export trade with Japan except in steel and iron will be practically negligible after the war, for she has become self-supporting and more in most of her industrial needs. The prosperity of the country is obvious when it is considered that foreign trade, which amounted to 32,000,000*l.* in the first quarter of 1917, had increased to over 99,000,000*l.* in the same period of 1918, also that the capital invested in Japanese industries increased from 28,000,000*l.* to over 58,000,000*l.* in a single year.

That Japan would eventually reach a state of industrial independence was without doubt to be expected, but her industrial domination of China was not, and yet it is possible, for the Japanese Government is doing everything it can to secure it. Thus Finance Minister Shoda in May, 1918, in an address to a general meeting to the bankers of Western Japan, emphasised the need for independent sources of supply for necessaries and expressed dissatisfaction at the amount of Japanese money invested in China although this amounted to 9,800,000*l.* in the year 1917 alone, not quite as much as Japan's total investment in the country previous to the war. He also said that for the encouragement of investment abroad, the Government had decided to guarantee principal and interest to the amount of 10,000,000*l.* in the Industrial Bank of Japan. This is sufficient indication of the Government attitude, and the further increase of Japanese power in China is to be feared for the following reasons, which give very little hope of the maintenance of the Open-Door policy under a dominant Japan.

Thus in the leased territory in Manchuria and in her colonies Japan has always stifled all competition either by high preference rates or by methods more questionable, as in Manchuria, where Chinese banks are compelled to cash a full face value note depreciated to the amount of 40 per cent. or over, if presented by Japanese nationals.

Methods like these, coupled with the notorious partiality of Japanese law courts, whether consular or otherwise, effectually discourage competition even without the fear that any competing business would not be killed immediately by transport difficulties on Japanese controlled railways.

Further no selection has been enforced by the Government in the matter of emigrants, with the consequence that the name of Japan is continually being discredited in China by undesirables who seem to form the bulk of Japanese emigrants, judging from the disreputable trades engaged in and the low standard of their trade morality.

In addition, the Government itself has at least laid itself open to the suspicion of fostering the continuance of the disastrous and wasteful war between North and South China, which has been going on since 1916, for she has lent money wholesale to North China, well knowing that there was at least considerable doubt about the loans ever being used for their ostensible purposes. Among the most notorious of these loans was the Arms loan of 1917 for 4,000,000*l.*, said to be for the equipment of the Chinese expeditionary force for the European war, but without doubt in part used for the purchase of war material for the war against the South. Among other exceedingly questionable loans may be enumerated the Telegraph Loan, previously mentioned, the proceeds of which were undoubtedly used for the war, a loan of 300,000*l.* to the rebel southern government in February, 1917, secured on the Canton cement works, a further loan of 200,000*l.* to the rebel southern governor of Hunan secured on iron mines in Anhui and antimony mines in Hunan, and lastly a loan known as the Military Loan of unknown amount, said to be 4,000,000*l.*, the terms of which are secret, but are supposed to provide for the military re-organisation of China under Japanese supervision.

Summarising the above we find the British manufacturer confronted with the almost total loss of the Japanese market, worth over 12,000,000*l.* in 1912 and then on the increase, and also with a very clever competitor in what promises to be one of the world's greatest markets. Further this competitor has the great advantage of proximity, strong Government backing both moral and financial, very low wages and a standard of living infinitely below ours, and last but not least a laxity of trade morals, coupled with great tenacity of purpose. It should also be remembered that since the War Japan has entered the market against us in almost every branch of Western industry, that their goods are at any rate extremely attractive, and have, in some cases, particularly as regards electrical goods and cement, proved very satisfactory, though in the great majority of cases they are inferior in quality, a defect largely counterbalanced by their cheapness, which appeals irresistibly to the half-trained mind.

Japanese industrial strength lies in organising and imitative ability, her adequate finance of industry which insists on getting the best and most up-to-date even if of foreign origin, and her supply of cheap labour, even in the case of the skilled artisan class.

Japan's weakness lies in her lack, amongst some classes, of that high standard of trade morality which is so necessary to establish credit and reputation, her mineral poverty, her dependence on outside sources for much of her food supply and all her wool supply, and the popular dislike of immigration, for out of 55,000,000 people, only 500,000 are resident abroad, while very many of these are undesirables.

THE ELECTRON-FURNACE SPECTRUM OF IRON.

Spectroscopy has placed wonderful means of research at our disposal. As first presented to the student, those means look very simple. With further study, however, the interpretation of spectra becomes increasingly difficult. We observe that the character of a spectrum changes with the mode of excitation and with the experimental conditions. Even the simplest element known, hydrogen, gives two entirely different spectra, one relatively simple, the other complex, but both more complicated than appears at first sight compatible with the assumption of a hydrogen atom consisting of a single nucleus and a single electron. With changes in the chemical conditions in electric potential and capacity, in temperature and gas pressure, with the presence of certain other elements and other factors, some lines become weakened or obscured, others enhanced. Under certain conditions the multilinear spectra of mercury and some other metals are reduced to one-line spectra. We are aware of these peculiarities but we do not always bear them in mind. We assign the same temperatures to flames and arcs giving the same spectra as if we assumed the energy of radiation to be ultimately thermal in nature. On the other hand, the vacuum-bulb spectra are discussed as if the potential applied constituted all the energy available, though the kathode is especially heated by battery current. We are hardly in a position to say which fractions of the various forms of energy —chemical thermal, electric—are consumed in excitating the radiations and to what extent they are concerned in the production of particular radiations. From this point of view the recent researches of Dr. G. A. Hemsalech,* conducted at Manchester, deserve attention. Experimenting with tubular electric furnaces Hemsalech finds that the bright lines of the iron spectrum are of electrical, not thermal origin, and he draws somewhat novel conclusions as to the excitation of spectra.

The researches were instigated by the investigation of the iron spectrum made by A. S. King at the Mt. Wilson Observatory in 1913. Comparing electric-furnace and arc spectra, King found that the changes in the relation intensities of the iron lines might in general be accounted for by a difference equivalent to large temperature differences. But the red lines seemed to require higher temperatures for their production than the blue lines, and the distribution of the lines through the visible spectrum bore little resemblance to the intensity gradation observed for the spectrum of an incandescent solid. The effective temperatures to which he assigned certain lines in flame spectra did not agree, moreover, with the temperatures which Hemsalech, collaborating with C. de Watteville and, later, with E. Bauer, had attributed to flames of coal-gas, oxy-hydrogen and oxy-acetylene. Hemsalech, therefore, started experiments with a carbon tube electric furnace. The metal or compound to be examined was either evaporated in the furnace, or the vapours were introduced into it by a special device; an arc was produced between iron electrodes in air or oxygen, and the oxide vapour was conducted into the furnace tube. The observations were made at atmospheric pressure, temperatures being determined with a Wanner pyrometer.

Unless cleared by a slow current of air or hydrogen the furnace was at first full of fumes. At about 2,400 deg. C. the furnace glowed in a purple light. As the temperature rose the whole interior became filled with a white glow and the carbon bands in the green and blue made their appearance. At 2,500 deg., near the boiling-point of iron, the furnace appearance underwent a further characteristic change. So far the appearance had been the same whether iron was present or not. Now, however, the glow assumed, in the presence of iron, a brilliant greenish-white hue and brilliant bright iron lines could be distinguished in the intense continuous spectrum. Hemsalech attributes the appearance of the carbon bands and of the iron lines to the ionisation of vapours.

That carbon gives off particles at high temperatures was proved by Harker and Kaye; such carbon particles would be shot off *en masse* above 2,500 deg., and would help to carry the current. Repeating the experiment of Harker and Kaye by inserting an axial rod of carbon as kathode into the furnace tube as anode, Hemsalech observed at 2,700 deg. thermoionic currents across the tube-gap of 3·6 amperes; when he further introduced iron into the furnace, the currents rose to 4·4 amperes and the iron lines burst out. When introducing (or generating) vapours of zinc, copper, silver, cobalt, nickel, in the furnace, however, he obtained merely the furnace spectrum and, in addition, nitrogen lines, but no metallic lines at all (except some absorption bands of copper). He concludes that the vapours of these metals are less ionised than the iron vapours; but he does not speak of thermoionic measurements made with the vapours of zinc, &c., which would have been valuable. When he cut off the furnace current, the lines persisted for some time—though not so long as in the larger furnace of King—certain groups of lines disappearing before others; the spectrum then observed did not correspond to the temperature of the cooling vapour. Further to test the assumed ionisation of the vapours he devised experiments in which the current would simply be the heating agent, other electric action being eliminated. He built up of three small plates of graphite a small box, open at the sides, and placed this box on a slab of graphite which he heated by continuous currents. Pieces of metal were boiled in the box, in which there should be no electric polarity. The inner space then showed the continuous spectrum of the hot graphite

* *Philosophical Magazine*, September and October, 1918, pages 209 to 230, and 281 to 296.

together with the lines of sodium and calcium (impurities of the graphite), but no lines of iron or of copper.

To account for these observations Hemsalech makes some suggestions both as to the mode of spectrum excitation and the stability of the molecule. When a compound like iron oxide is decomposed by heat, he argues, it is not really split into free atoms of iron and of oxygen; these atoms remain associated by a certain chemical affinity even at 2,700 deg., and the compound molecule, although certainly changed in so far as the relative positions and orbital motions of the component atoms are concerned, retains a certain individuality. Hence the line spectrum emitted by an iron compound at the highest temperature, though intense, is still restricted in range by some force, and thermal action can only produce certain lines. On the other hand, the electric forces at work in the arc and in the condensed spark really set the atoms free so that they can vibrate without restrictions. Thus Hemsalech would distinguish the following modes of spectrum excitation: (*a*) Thermal, without chemical or electric action, yielding an iron spectrum devoid of lines and bands; (*b*) thermochemical action, yielding incompletely dissociated atoms, still chemically associated, though restricted in their vibrations—the respective iron spectrum is observed in the mantles of gas flames and in electric furnaces up to 2,500 deg.; (*c*) chemical excitation involving complete dissociation of the oxide and formation of a new compound between iron and nitrogen, whose mutual affinities increase at high temperatures; (*d*) thermoelectric excitation above 2,500 deg., when the electric discharge passes through the ionised metallic vapour; the ordinary electric arc is a special case of (*d*) in which the ionisation is maintained by the potential applied; (*e*) electric excitation which occurs with sparks of capacity and self-induction at ordinary temperature, the radiating vapour being produced by the direct action of the discharge on the molecules in the surface layer which are hurled into the spark gap.

There is one more point to which Hemsalech draws attention. We know nothing about the actual temperatures of the radiating atoms in these sources, because all the measurements made refer to the inner wall of the furnace or to the arc electrodes. In cold luminescences, which can be studied spectroscopically, the average temperatures are certainly not high, however. The classification proposed deals particularly with the spectra of iron and its compounds. In the cases of other metals the relative importance of the various modes of excitation would be different. One lesson to be drawn, we think, is further caution in the interpretation, particularly of stellar spectra. The astrophysicist classifies spectrum-types by the relative intensities of certain lines and speaks of stellar surface temperatures of many thousands of degrees. He watches the spectrum of a small discharge tube or a furnace and compares it to the spectrum of a star produced under conditions of which he knows nothing. The spectrum he sees may represent the totality of the superimposed spectra of an immense number of furnaces or clouds which may owe their existences to various modes of excitation; the absence of certain lines does not prove the absence of their elements, nor the enhancement of other lines their predominance. Collie and Watson found, last autumn, that the presence of helium and of neon had peculiar effects on certain cadmium lines; the helium lines themselves are easily obscured by the presence of other elements.

Sixty years of spectroscopy have helped us to wonderful achievements, especially in the exploration of the universe. But one cannot help doubting sometimes whether the astrophysicist pays sufficient regard to the scale of his speculations. When he explores the sun, he has at any rate a fair-sized disc to examine, on which eclipses and observations in the light of special radiations further enable him to make distinctive local studies. With stars he lacks all these aids of exploration. The biggest stars remain mere dimensionless points in the most powerful telescopes, and, on the whole, of the spectroscopic cosmical triumphs those secured by the application of the Doppler principle appear to be the most reliable.

MEMORY AND JUDGMENT.

IT was Samuel Butler (the author of "Erewhon," not the bishop) who developed the thesis that intellect itself was developed and transmitted memory, that intelligence itself was the recollection of experience passed on to future generations, that of and by itself memory was sufficient explanation of intelligence.

Butler's thought on this subject should not be dismissed lightly, it is a useful hypothesis even if exact proof be lacking, it helps for instance to sort out humanity into two groups and earmark superior intelligence even where this is latent. The two classes are those whom experiences teaches and those who repeatedly commit the same mistakes. Superior intelligence according to Professor Bain consists in a large development of the faculty of association by similarity and we are also reminded that exact verbal memory is not a proof of intellect.

What really does matter is sound judgment, an instructive appraisal of what is correct, accurate, true, expedient or fitting; this depends upon the entire individual mentality, not upon simple recollection. Judgment may be termed digested memory tempered by experience and uncommon sense.

Reliable judgment is of the greatest value in every walk of life, its deliberate cultivation is of prime importance, it is in some senses comparable more to instinct in its immediate certitude than to any process of evolved reasoning.

The theory of Butler and the definition of Bain both enter into the equation of reliable judgment, neither perhaps explain it but they help us to understand it.

Trained intelligence is the foundation for the superstructure of instinctive appraisal; the initial standards of comparison soaked into the consciousness of the individual are all important, for unless these are above suspicion it will warp the mind when faced by the need for quick decision.

A slowly-matured mind has many advantages, youth is apt to overlook that the full benefits of really liberal education is not in the immediate application, but in the maturity of judgment given later. It is not so much the immediate utility as the type of mind created.

The rapidity and certainty of a trained expert in any line is most often a puzzle to the onlooker even where he has faith in the decision. As Whistler said, the pay was not for the job or the time involved, it was for knowing how. Such ability is not gained at a stride, nor by any easy intuitive process.

Every article marketed is a challenge to the customer upon whose judgment and faith depends the sale. In many industrial matters, especially in mechanical connections, the appeal is to a specialist tribunal, every member of which has expert judgment in some degree.

Unless close association does turn experience into instructive judgment there is lacking a natural capacity which will always retard the full expansion of the individual and place him in an inferior classification.

The matter has relative importance, for the position occupied does not affect the argument, it is as necessary to absorb at the lower no less than at the higher levels. Certainly the faculty now discussed grades men into distinct categories.

Constructive criticism is itself a valuable mental attitude and one worth diligent cultivation by those who aspire to the higher rungs in the industrial ladder. Criticism of this type involves close mental comparison, in itself an excellent mental exercise. The instructive judgment desirable is not raised without pain and supplication.

When capacity and competence are terms used to describe a man it is this quick instinctive mental quality which is inferred; ability to wrest circumstance and difficulty to advantage is the outcome of instinctive judgment. The mental horizon of such an individual is of large circumference, while it passes over no detail as trivial or negligible.

The mind of requisite calibre, in spite of its larger generalisations, has usually a close regard for detail, the greater includes the less, attention to detail within a limited orbit give rise to mental processes which build up the memory cells upon which the larger views are founded. There are too many superior men who labour at dignity who affect to despise triviality, forgetting that the trivial can easily become the dominant factor in manufacturing process. Indeed, it has usually been some obscure point which has caused all the trouble in a new process, its solution took endless patience and disentanglement, and needed large mentality to salve.

Some years ago a friend distinguished for his high technical attainments was offered a very considerable fee if he could solve an outstanding trouble of a score of years in a first-class product. The trouble had been investigated by all in close touch, every now and again a quantity proved unreliable. The facts were placed before him, a day spent in travelling to and from, and 30 minutes, earned the fee. What had puzzled the manufacturer and worried out his life was solved in a few minutes by the simplest imaginable device.

This was instinctive judgment based upon long training and high mentality. Not all industrial problems are as simply solved.

There is no easy road to pre-eminent ability whatever the natural endowment, if acquisition is easy, the mental exercise which builds up lasting qualities is absent and a tendency to sloth is often evident. An intelligence less naturally keen has an asset of value, in that the greater labour needed is apt to induce greater permanence. Initial endowment is therefore perhaps less meritorious, greater diligence frequently equalises quick mentality due to the respective characters of the possessors. So that superior mentality, recognised practically everywhere, rests perchance in the last analysis as much upon character as upon any initial superiority. Character plus capacity, mutually reacting upon each other in a single mind give an ideal combination whose worth cannot be over-assessed. It is, of course, unwise to dogmatise too far upon so intangible a subject but experience digested gives judgment, and it is this more than verbal knowledge which is the real aim of all training, educational and otherwise; it is the whole mind which matters just as the product of life itself should be whole men.

TRADE OF BRITISH GUIANA.—The following table shows the trend of trade of the Colony during 1917:—

Countries.	Imports.	Exports.	Aggregate Trade.
	per cent.	per cent.	per cent.
United Kingdom	32·70	43·07	38·87
Dominion of Canada ..	15·15	39·69	26·82
Other British Possessions ..	5·88	9·28	7·20
United States of America ..	42·38	3·81	18·57
Other foreign countries ..	3·89	4·15	3·54

The United Kingdom's share of the aggregate trade for the year was more than that of 1916 by 1·85 per cent.; Canada's share decreased by 1·07 per cent.; while that of the United States increased by 2·04 per cent.

CHEMICAL INDUSTRIES IN SWEDEN AND NORWAY.—Considerable advance has been made in Sweden during the war in the manufacture of aluminium compounds, caustic soda and potash and bleach, further in ammonium compounds (except sulphate), green and blue vitriols, calcium carbide and hydrochloric acid. Potassium nitrate, nitrobenzene, silicon carbide and trinitro toluene are new products, whilst the manufactures of phosphoric acid, prussiate of potash and nitric and sulphuric acids were temporarily abandoned. A rubber factory was to start at the end of last year in Landskrona; the Elektrolys Company, of Stockholm, supplies hydrogen peroxide. In Norway the total capacity for making cyanamide will, with the completion of the plants at, Aura and Bjelvefossen, reach 800,000 metric tons. The Birkeland-Eyde process at the Norsk Hydros in Telemarken might produce annually 120,000 tons of nitric acid, but the actual output of acid in 1916 was only 4,000 tons, most of the nitrogen being converted into the nitrates of calcium, sodium or ammonium. The export of Norwegian saltpetre sank to 46,000 tons in 1916 (70,000 tons before the war). Phosphorus, sufficient for the match industry of the country, is made in two works; zinc white and lead white are made in one factory, while another concern supplies titanium white, a novelty. Ferrosilicon (25,000 tons in 1916) comes from eight works, metallic sodium from two; these products have gone up, whilst the manufacture of ferrochrome has diminished. There are four aluminium-smelting works; electrolytic copper and nickel are made in Kristiansands; there are also electrode works. The electrochemical products of Norway were estimated at 89,000,000 kroner in 1911 and at 368,000,000 kroner in 1916.

THE OPTICAL DETERMINATION OF STRESSES IN AEROPLANE SPARS.

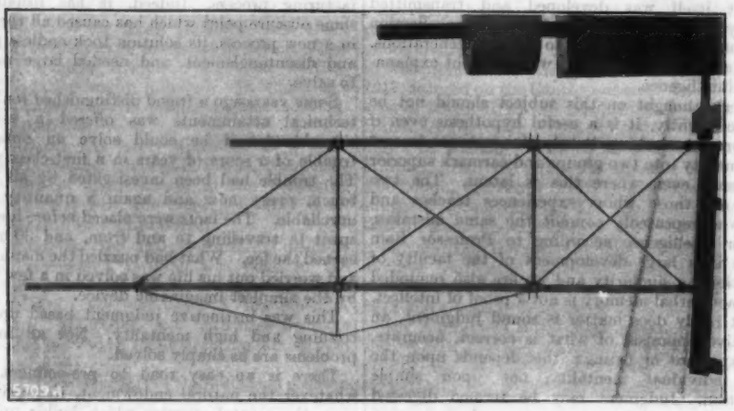


FIG. 1.

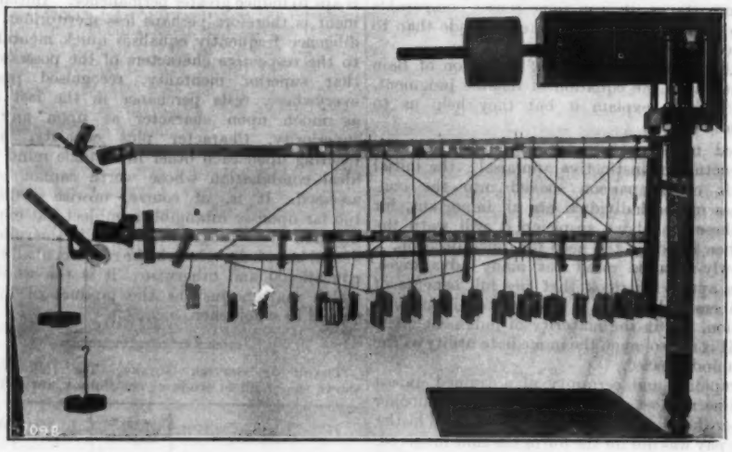
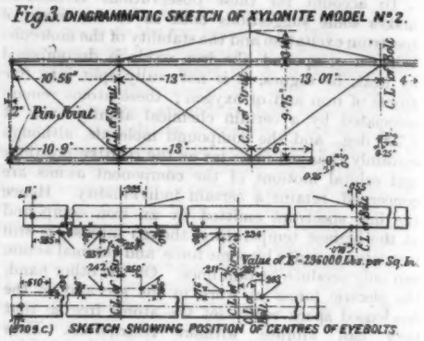


FIG. 2.

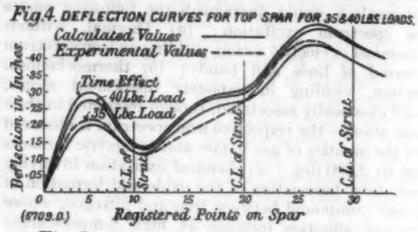
AT a recent meeting of the Royal Aeronautical Society, Major A. R. Low, R.A.F., described a series of experiments in which optical methods were employed to determine the stresses on aeroplane spars. The stresses on these spars are of a somewhat peculiar character. Roughly speaking, each may be likened to a continuous girder supported at three or four points, and at the same time subjected to a heavy axial stress. Failure may thus occur either through crippling, or by bending, or by a combination of the two. If the axial thrust were very low, the spar might be treated as a simple continuous beam, whilst if the transverse bending were very small Euler's theory of struts would be applicable. Actually neither alternative is permissible. A complete solution of the problem from the mathematical standpoint was worked out many months ago by the scientific section of the Air Ministry, and the methods of calculation thus derived have been largely adopted by designers. In his paper, Major Low compares the results as computed by this theory with the stresses as determine optically, and finds that the discrepancy between the two is sometimes very considerable. The work was carried out at University College, where Professor Coker placed his unique equipment for investigations of this kind at Major Low's disposal. A scale model of a standard pattern of spars and bracing were made, using Xylonite for the spars and steel for the struts and bracing wires. A view of this model for testing is represented in Fig. 1, whilst Fig. 2 shows it under load. It should be stated that the horizontal rods visible in Fig. 2, are merely supporting frames—the actual spars can be seen below and above these—and it will be noted that the deflections were in all cases very large. The dimensions of the model are given in Fig. 3, whilst in Figs. 4 and 5 a comparison is made between the deflections and stresses as computed and as determined by the observations. The discrepancies, are, it will be seen, very considerable, particularly at the higher loads. In part, this is no doubt due to the fact that in making stress calculations it is always assumed that the deformation of the body under study is so small that its shape is not materially altered by the application of the load. This condition was not satisfied in the experiments, but it is claimed that in actual practice aeroplane spars have occasionally to sustain very large deflections, and that the conditions in these tests approximate accordingly more closely to the actual conditions than do the assumption necessarily made as a basis for calculation. The greatest discrepancy found between calculation and observation was in the position of the points of contrary flexure. In general, the displacement from the computed position was such as to reduce the maximum value of the stress. A full description of the principles involved in the optical measurement of stress and of the methods employed will be found in an article by Professor E. G. Coker which was published in our issue of January 6, 1911. We need, therefore, only recall here the fact that when a beam of polarised light is passed through a transparent body under strain, the latter acts like a crystal of Iceland spar. It resolves the incident beam of light into two components, which travel through the strained material at different velocities, and hence when on emergence the two components, or parts of them, are again combined interference effects are obtained, giving rise to wonderful displays of colour. The tint of the colour at any part is a measure of the stress there, and the intensity of this stress is generally determined by finding what load must be applied to a simple tension piece to obtain a corresponding colour. In practice the tension piece and the model are traversed by the light in series, the axis of the tension bar being at right angles to the direction of the stress on the model. The load on the tension bar is then adjusted till the colour effect is annulled, in which case the stress on the tension piece is equal to that on the corresponding part of the model.

Fig. 3. DIAGRAMMATIC SKETCH OF XYLONITE MODEL No. 2.



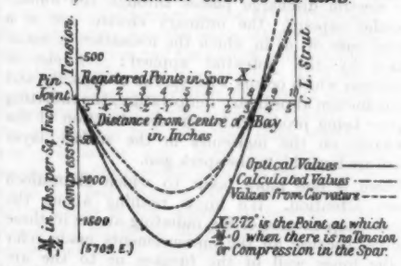
(5709.c) SKETCH SHOWING POSITION OF CENTRES OF EYEBOLTS.

Fig. 4. DEFLECTION CURVES FOR TOP SPAR FOR 35 & 40 LBS. LOADS.



(5709.D.)

Fig. 5. STRESS IN BAY "A" DUE TO BENDING MOMENT ONLY, 35 LBS. LOAD.


Tension.
Pin Joint
Registered Points in Spar
C.L. Strut
Distance from Centre of Bay in Inches
Compression.
M in Lbs per Sq. Inch
Optical Values
Calculated Values
Values from Curvature
X=272" is the Point at which M=0 when there is no Tension or Compression in the Spar.

(5709.E.)

ITALO-AMERICAN COMMITTEE'S PLANS.—According to the *Corriere della Sera*, the Italo-American Economic Committee, which was formed at the end of last year, is now ready to commence its practical work, which will be as follows:—(1) Agreements between competing producers so as to eliminate the waste of unregulated competition. (2) Agreements for the increase of sales of non-competing products in the two countries and eventually to organise deposits for redistribution to other markets. (3) Development and introduction into Italy of industries, with Italian and American capital, on modern lines, giving a maximum of efficiency. (4) Investment of Italian and American capital for the development of the natural resources of Italy.

RECOVERY OF ANIMAL FATS.—The dearth of fats, which the war brought to Scandinavia as well as to other countries, has instigated experiments on the better extraction of fats from carcasses. So far this extraction had been effected by means of boiling water and had, therefore, really been a melting process. A company has been established in Sweden (*Teknisk Tidskrift*, October, 1918) which will extract the fat by means of benzene. The carcases are to be flayed and cut up at special collecting depots, which send their material to the factories to be dealt with in large horizontal steel vessels of 2½ tons capacity. Fish refuse is preliminarily dried. The extracted mass is likewise dried and ground; the meal obtained is said to contain up to 60 per cent. of protein and to yield a good cattle food, especially when mixed with molasses.

THE MANUFACTURE AND DESIGN OF TOOTHED GEARING.*

By JOSEPH CHILTON.

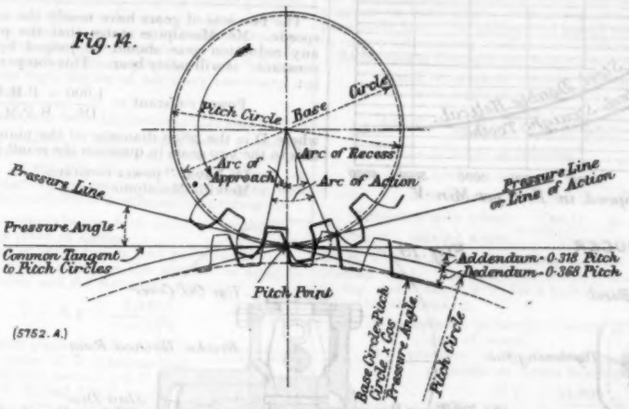
(*Concluded from page* 207.)

DESIGN.

The three principal factors governing the design of wheel teeth, viz., strength, durability and efficiency, are closely related. Strength is the principal factor in slow speeds, the other two increase in importance with the speed. They conjointly depend on the shape of the tooth.

It has already been mentioned that the involute is universally adopted for machine-cut wheels. Fig. 14 shows a pair of wheels in gear, and the essential parts of the system. The parts which the designer who seeks perfection can alter, are the pressure angle and the tooth length. The base circles bear a constant ratio to the pitch circles, being equal to the pitch circle multiplied by the cosine of the pressure angle. An increase of pressure angle therefore involves a decrease in base circle diameter. The contact between two mating teeth must be on the pressure line if correct action is to be maintained. With the standard proportions of teeth for the 14½-deg. pressure angle system, as given in Fig. 14, a large proportion of the pinion tooth is below the base circle. This part of the tooth is worse than useless when wear takes place, as wear allows the top part of the wheel tooth face to come in contact with the pinion tooth below the base circle; that is, off the line of pressure, with the consequence that the driven wheel is subject to periodic accelerations and retardations during the contact of each pair of mating teeth and, although the variations of velocity may be very small, the forces resulting may be very large when the variations occur in a short time interval.

Fig. 14.



Vibration, noise and tooth breakages occur when small numbers of teeth are used in high-speed spur wheels. With low speeds the number of teeth is not so important. The minimum number of teeth is usually taken as 12, and the length of tooth is such that a pinion of 12 teeth will have an arc of action equal to one pitch, so that there is always one pair of teeth in mesh to ensure continuity of action. Teeth should not be lengthened in order to gain the advantage of having two or more teeth in gear to lessen the pressure per tooth, as a lengthening of the arc of action is conducive to wear. An analysis of tooth wear shows that, for any pressure angle system, the greatest relative sliding between two tooth faces in contact occurs at the extreme ends of the maximum possible arc of contact. As the point of contact moves towards the pitch point the action between the faces of the mating teeth approximates more nearly pure rolling; at the pitch point it is pure rolling. By increasing the pressure angle and, at the same time, shortening the tooth, it is possible to use an actual arc of contact much less than the maximum possible. The arc used is that part which gives approximation to rolling. Hence other systems than the 14½ deg. are used, 20 deg. with stub tooth; 22½ deg. and even 28½ deg. have been tried for helicals.

The decrease in base circle diameter, due to increase in pressure angle, lessens the proportion of tooth length inside the base circle, minimising "interference," as the action of contact below the base circle is called. There are limits to the increase of pressure angle, one is that the pressure on the bearings increases with the secant of this angle and another that when used with small numbers of teeth of coarse pitch the tooth must be increased in length to get the necessary length of arc of action, which means increased wear. Twenty deg. is much used, 22½ deg. occasionally, 28½ deg. rarely.

Another method of obviating "interference" and its consequent evils is the increased addendum method. This may be used with any pressure-angle system, standard or stub teeth. It consists in increasing the pinion addendum and decreasing the addendum of its mating wheel, the distance between the shaft centres may be the same as in gears of standard dimensions. Advantages similar to those before-mentioned accrue. The arc of approach is somewhat shortened with a corresponding lengthening of the arc of recess, and as friction during approach is greater than friction during recess a slight increase of durability and efficiency is obtained.

Both systems give a stronger form of tooth due to increased thickness near the root; this applies particularly to the pinion, the vital factor in gear combinations. The face of the pinion tooth is of flatter curvature, that is the radius of curvature is increased. This increases the oil-retaining qualities of the tooth, decreasing wear, increasing efficiency.

The strength of single-gear teeth of 14½ deg. and 20 deg. pressure angles has been determined with great accuracy by Mr. Wilfred Lewis. His method is shown in Fig. 15. It is based on the assumption that the whole load acts at the extreme end of the tooth, its direction being along the pressure line. This force P is resolved into radial and tangential components, the radial force producing a uniform compressive stress on the tooth section and the tangential a bending stress.

Using large-scale drawings, he determined the weakest section of the tooth, i.e., the lowest value of the ratio $\frac{\text{thickness}^2}{\text{distance to B}}$ or $\frac{s^2}{h}$ and constructed a parabola passing through B and tangential to the tooth profile at the weakest section. This parabola is the well-known cantilever beam form of uniform strength. His results may be expressed by the formula :—

$$\text{Strength constant } Y = \left(0.124 - \frac{0.684}{n}\right) \text{ for } 14\tfrac{1}{2} \text{ deg.}$$

$$Y = \left(0.154 - \frac{0.912}{n}\right) \text{ for 20 deg.}$$

where n is the number of teeth in the wheel under consideration.

Some values of Y are given :

No. of Teeth.	Y 14½ Deg.	Y 20 Deg.
12	0·067	0·078
13	0·070	0·083
14	0·072	0·088
15	0·075	0·092
16	0·077	0·094
17	0·080	0·096
18	0·083	0·098
19	0·087	0·100
20	0·090	0·102
21	0·092	0·104
23	0·094	0·106
25	0·097	0·108
27	0·100	0·111
30	0·102	0·114
38	0·107	0·122
50	0·112	0·130
75	0·116	0·138
100	0·120	0·142
Rack	0·124	0·154

The working load per inch of tooth P is given by the equation $P = Y \times p \times$ stress, where p is the circular pitch and the stress depends on the material used and the working conditions, i.e., speed, &c.

Some designers use the strength factor irrespective of the number of teeth that may be in gear, and consequently sharing the load. This is apt to lead to coarse pitches. If two teeth or more are in gear the load may be taken as shared between the nearest smaller whole number, that is, if the arc of action divided by the circular pitch is, say, 2·6, then the load is distributed over two teeth. Some approximate proportions are given :—

Pinion.	Wheel.	Reduction Ratio.
26	rack.	
27	176 to rack	6·5 upwards.
28	90 to 175	3·2 to 6·25
29	44 to 89	1·52 to 3·0
30	30 to 43	1·0 to 1·44

These values are for 14½-deg. pressure angles. In pinions between 13 teeth and 26 teeth the load comes on one tooth during part of the arc of action, and on two during the remainder. Some designers allow for this as it certainly lessens the stress, although it is a cause of uneven wear.

Friction of wheel teeth has been investigated by Professor R. H. Smith, who found that the work wasted by tooth friction in a pair of wheels of tooth numbers N and n may be expressed by :

$$W = 1.06\,\mu\frac{N+n}{N\,n}$$

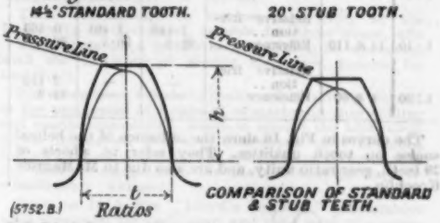
A corresponding investigation by Realeaux gives :

$$W = k\,\pi\,\mu\left(\frac{1}{N}+\frac{1}{n}\right)\frac{a}{p}$$

where k is a constant derived from experience and $\frac{a}{p}$ is the ratio of the arc of action to the pitch, μ is the coefficient of friction.

These expressions are similar to each other, and both show the value of large numbers of teeth, more particularly in pinions. This means either big wheels or fine pitches and leads to helical wheels which are free from many of the disadvantages of the straight spur tooth. In helical wheels each tooth comes gradually into action without shock; there is no sudden transference of load from one tooth to another. The pressure on the face of a helical tooth acts on a diagonal line at an average of about half the height, and the total load may be taken as being uniformly distributed between the teeth that are in the arc of contact. If cut with standard cutters

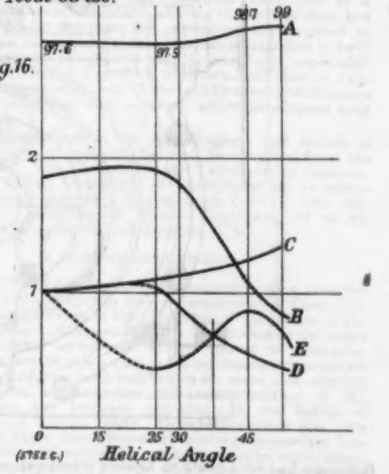
Fig. 15.



Ratios

A.-Percentage Efficiency.
B.-Ratio of Arc of Contact to Pitch.
C.-Ratio; Root thickness to thickness at Pitch.
D.-Loss of Work by Friction. (Line
E. Tooth Stress.

Fig. 16.



Helical Angle

the tooth height is equal to the standard height for the circular pitch multiplied by the cosine of the helical angle. If a = helical angle :

then a = 23 deg.	$\cos a = 0{\cdot}921$	(A)
a = 30 deg.	$\cos a = 0{\cdot}866$	
a = 45 deg.	$\cos a = 0{\cdot}707$	

The correct basis for tooth form in helical wheels is a section taken at right angles to the teeth. On such a section the pitch circle becomes an ellipse and the teeth are cut where the radius of curvature is a maximum. If r is the radius $r = \frac{D}{2\cos^2 a}$, where D is the diameter of the pitch circle.

Values for angles given above are :

a	$\frac{D}{2\cos^2 a}$	
23 deg.	= 0·59 D	(B)
30 deg.	= 0·66 D	
45 deg.	= D	

We see that the tooth form is developed on a circle larger than D in diameter, and combining equation A with equation B the tooth form is equivalent to that of a straight tooth spur wheel having :

when a = 23 deg. $\frac{2 \times 0{\cdot}59}{0{\cdot}921} = 1{\cdot}28$ times as many teeth.

30 deg. $\frac{2 \times 0{\cdot}66}{0{\cdot}866} = 1{\cdot}54$ times as many teeth.

45 deg. $\frac{2 \times 1}{0{\cdot}707} = 2{\cdot}83$ times as many teeth.

Comparing the helical tooth resistance for wheels of 30 teeth with spur wheels of the same number of teeth, it can be shown that when the bending moment due to

* Paper read at the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, February 11, 1919.

the pressure on the teeth is equated with the resistance of the tooth section, the relative stresses are as follows :—

Straight spur	1·0
23 deg. helical	0·48
40 deg. helical	0·50
45 deg. helical	0·868

This shows that for stress, values of helical angles between 23 deg. and 30 deg. are best. Taking efficiency by the Realeaux formula with a coefficient of friction of 0·15, and allowing for the variation in the ratio of arc of contact to pitch due to variation of gear ratio, M. Maurice Koechlin gives the following data concerning the efficiency of spur and helical gearing :—

Gear Ratio.	Number of Teeth.	—	Straight Teeth.	25 Deg. Double Helical.	45 Deg. Double Helical.
1 : 1	30 & 30	Relative friction	1·0	1·033	0·567
		Efficiency ..	97·6	97·5	98·7
1 : 5	15 & 75	Relative friction	1·2	1·24	0·719
		Efficiency ..	97·1	97·0	98·4
1 : 10	11 & 110	Relative friction	1·443	1·491	0·863
		Efficiency ..	96·6	96·5	98·1
1 : 20	4 & 80	Relative friction	—	—	2·110
		Efficiency ..	—	—	94·0

The curves in Fig. 16 show the influence of the helical angles on tooth qualities. They refer to wheels of 30 teeth, gear ratio unity, and are also due to M. Maurice Koechlin.

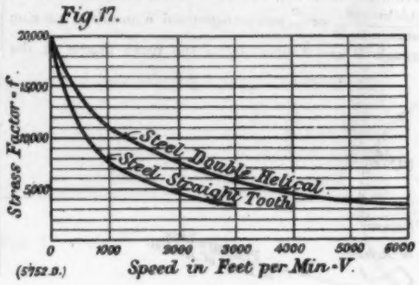
or air compressors, are subject to periodic load variations. If this factor is 1 for a constant torque it may be taken as equal to the ratio of the maximum to the mean for a varying torque. Obviously wear is largely influenced by the method of lubrication used. At speeds above 2,000 ft. per minute spray lubrication, on the entering side, is essential. Under this speed, bath lubrication is sufficient. The factor in these cases may be taken as 1. For good grease lubrication 1·1 to 1·25 and for very indifferent lubricating conditions 1·25 to 1·35.

A formula which covers most ordinary cases is $P = \frac{f Y p}{T L}$

where :

P = load in pounds per inch of width.
f = stress factor depending on speed and material used.
Y = tooth strength factor (Lewis).
T = ratio of maximum to mean torque.
L = lubrication factor.
p = circular pitch.

Fig. 17.



(5752 B.)

steel with a cast-iron centre. The gearing is mounted in a cast-iron casing with spray lubrication. The bearings are fixed, the pinion is part of a flexible shaft, and power is taken off the wheel shafts by flexible couplings.

It is interesting to compare the 300-h.p. set with a Melville-Macalpine gear of the floating frame type. The particulars are taken from ENGINEERING, March 23, 1917 :—

Maximum B.H.P.	Pinion R.P.M.	Wheel R.P.M.	Pinion Pitch Diameter.	Wheel Pitch Diameter.	No. of Teeth of Pinion.
2,670	3,750	750	6·74	33·7	23

Pitch.	Width of Tooth Face.	Velocity at Pitch Circle.	Lb. Pressure per In. Width of Face.	Helical Angle.
in. 0·9206	26·5	ft. per sec. 110	404	30

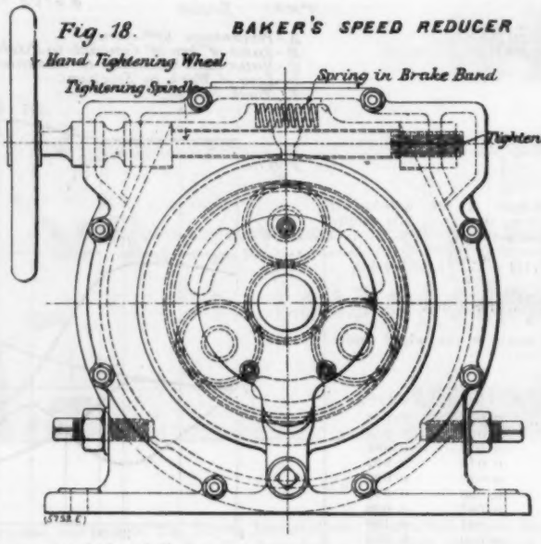
The two sets of gears have nearly the same pitch-line speeds. Mr. Macalpine states that the performance of any reduction gear should be judged by the "power constant" it will safely bear. This comparative constant is :

$$\text{Power constant} = \frac{1{,}000 \times \text{B.H.P.}}{D^3 \times \text{R.P.M.}}$$

where D is the pitch diameter of the pinion. Applying this to the two gears in question the result is :

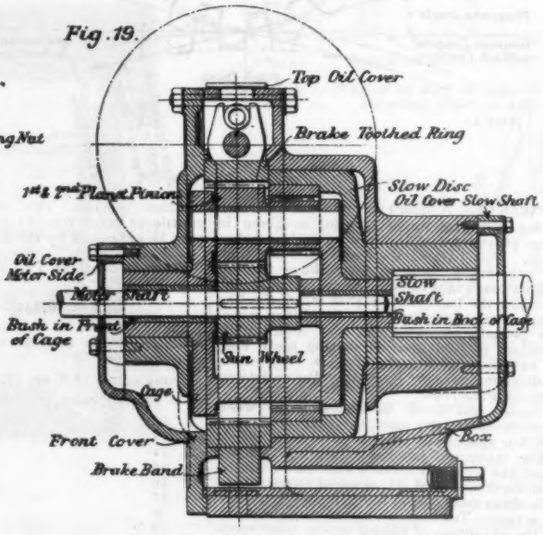
De Laval "power constant" = 1·9
Melville-Macalpine " = 2·4

Fig. 18. BAKER'S SPEED REDUCER



(5752 E.)

Fig. 19.



Reference has been made to Lewis's investigations on tooth strength. In addition to determining the factors already tabulated, he gives a series of values for the working stress for various materials and speeds. They refer to straight teeth.

Lewis's Values of Stress f.

Speed in Feet per Minute.	100 or Less.	200.	300.	600.
Steel	20,000	15,000	12,000	10,000
Cast-iron ..	8,000	6,000	4,800	4,000
Speed in Feet per Minute.	**900.**	**1,200.**	**1,800.**	**2,400.**
Steel	7,500	6,000	5,000	4,300
Cast-iron ..	3,000	2,400	2,000	1,700

These stress factors agree closely with the expression $f = f_1 \frac{600}{600 + V}$, where f_1 is the stress factor in the first column and V is speed in feet per minute. For double helical teeth, which are generally more accurately cut, and are more suitable for the higher speeds, this formula may be modified as follows :

$$f = f_1 \frac{1{,}200}{1{,}200 + V}$$

Comparative curves are given in Fig. 17. In designing teeth, this stress factor must be used in conjunction with the factor for tooth strength previously mentioned, in order to find the permissible load per inch of width. Any formula which aims at covering practical cases must take into consideration wear and torque variation. The teeth of gearing driving reciprocating machinery, such as pumps

The formula may be used for either straight spur or double helical teeth. The value of f for any particular material, such as chrome nickel steel, may be adjusted to the higher tensile strength. In double helicals the influence of the helical angle on the stress may be taken into consideration. High-speed gearing demands fine pitch and concurrently wide face to obtain the necessary wearing qualities, together with strength and absence of noise. Low speed, heavily loaded gearing, such as that used in rolling mills, requires different treatment ; coarse pitches and relatively narrow gearing is the rule.

TURBINE REDUCTION GEARING.

The gearing used in the De Laval turbine seems to be the prototype of modern high-speed reduction gear. Some dimensions of this gear are given in the accompanying table :—

Pinions.

H.P.	Outside Diameter.	No. of Teeth.	Pitch.
			in.
10	1·077	21	0·15
75	1·53	19	0·234
110	1·82	23	0·234
300	2·65	31	0·26
	Wheels.		
10	10·1	206	0·15
75	15·7	208	0·234
110	18·89	250	0·234
300	29·20	362	0·26

The speed of the 300-h.p. set is 10,600 r.p.m., and gives about 110 ft. per second at the pitch line of the pinion. The pinion is made of 0·6 per cent. to 0·7 per sent. carbon steel, the wheel rim of 0·2 per cent. carbon

The power constant is a useful aid in determining pinion diameters.

Mr. Macalpine gives the following as the practice of the Westinghouse Machine Company :—

Gears for driving electric generators ...	3·0
" " merchant ships ...	3·5
" " war ships	4·0

This is for gears of the "floating frame" type. He gives figures showing that the usual British practice using rigid gears is about 2·0.

The pinion diameter is $D = \sqrt[3]{\frac{1{,}000 \times \text{B.H.P.}}{\text{power constant} \times \text{R.P.M.}}}$

One of the factors limiting the power transmitted by gearing is the unequal distribution of tooth pressure due to misalignment of bearings and torsional and cross-bending of pinions. The Melville-Macalpine floating frame is designed to equalise the distribution tooth pressures. It consists of a very stiff frame carrying the pinion bearings, supported near the middle of its length by the bedplate, but (when the teeth are not in mesh) very free to move about an axis transverse to the axes of the wheel and pinion. The exact position of the pinion axis is in part determined by the interaction of the teeth. It is claimed to be very effective in giving equality of distribution of tooth pressure.

Another method of ensuring equality of distribution is the use of wheels which are built up of a number of plates machined to a form which gives them a certain degree of lateral flexibility. This compensates for the torsional yield in long pinions. The pinions in this system are solid. Like the floating frame it is used in America. The inventor claims that very fine pitches may be used.

British turbine makers seem to use finer pitches than those used in the Melville-Macalpine gear, where pitches as coarse as 1¼ in. have been used. British practice is to maintain a constant or nearly constant pitch for all

diameters of first-motion pinions; in the Melville-Macalpine gear the pitch seems to increase with the diameter.

The question of pitch and working load per inch of tooth width for turbine gearing can only be solved by experience. The oil-retaining qualities of the tooth, the accuracy of shape, pitch and helical angle, and the character of the bearings used, each have their influence.

Some form of self-aligning bearing combined with a certain amount of flexibility in the wheel teeth seem to be necessary, the first to correct stress deflections, the second to accommodate inevitable inaccuracies. The limiting speed is mainly a question of accuracy. Mr. Daniel Adamson has suggested a standard of allowable inaccuracies in the pitch of teeth of straight spur wheels.

Velocity in feet per second ..	100	200	300	600	900
Inaccuracies in per cent. of pitch ..	5·0	1·76	0·96	0·34	0·185
Velocity in feet per second ..	1,200	1,500	1,800	2,100	2,400
Inaccuracies in per cent. of pitch ..	0·12	0·09	0·065	0·052	0·042

Although these speeds stop short of turbine practice, they are instructive, being the opinion of a recognised expert who has studied many phases of the subject. They indicate the high degree of accuracy necessary in high-speed gearing.

Tooth Pressures for Lubricated Gearing.

The following method of determining tooth pressures, for spur and double helical reduction gearing is used by an Italian firm. Lugi Pomini, Castellanza, Milan. It has been found to give good results with spur gearing, and is being applied tentatively to double helical gearing :—

P = load in pounds per inch of width of tooth.
p = circular pitch in inches.
v = velocity of pitch line in feet per second.
R = a factor depending on the number of teeth in the pinion and the reduction ratio.

$$P = R\,p \times \frac{1{,}480}{v + 32{\cdot}8}$$

For cast-iron spur gears the value of P is taken as above.
For steel spur gears 3P is taken as load.
For cast-iron double helical 1·5 P.
For steel double helical 4·5 P.
Values of R are given in the table and apply to enclosed lubricated gearing.

Reduction Ratio.

No. of Teeth in Pinion.	1:1	1:2	1:3	1:4	1:5	1:6	1:8	1:10
12	2·8	3·4	3·8	4·2	4·36	4·54	4·8	5·0
14	3·2	3·8	4·2	4·6	4·88	5·08	5·4	5·6
16	3·5	4·2	4·64	5·06	5·36	5·58	5·84	6·1
18	3·8	4·4	5·0	5·4	5·76	5·96	6·24	6·44
20	4·2	4·9	5·4	5·9	6·2	6·4	6·88	6·9
24	5·0	5·76	6·3	6·8	7·04	7·3	7·6	7·8
28	5·7	6·4	7·04	7·6	7·88	8·14	8·5	8·64
32	6·4	7·28	7·92	8·4	8·8	9·04	9·4	
36	7·2	8·1	8·76	9·24	9·6	9·88		
40	7·9	8·84	9·56	10·28	10·44			

These factors have been deduced from observations on the wear of lubricated teeth with circular pitches varying from ½ in. to 2½ in. They are valuable in determining tooth pressures for high-speed gearing where wear is the determining factor.

Fig. 18 shows a typical modern spur reduction gear for small powers. The toothed wheels are totally enclosed and run in oil. The epicyclic principle is adapted in the design and almost any reduction ratio up to 2,000 to 1 may be obtained. By the use of three pinions, gearing into the final internal driving wheel, the load is spread over a large number of teeth. The final wheel is consequently of small diameter, and the whole design very compact. Overhung pinions are absent, the whole of the toothed gear is of special forged steel, and is not heat-treated or hardened after forging. Some particulars of tooth pressures on the final internal wheel are given in the table below :—

Pitch. D.P.	Pitch. C.P.	Speed in Feet per Minute.	Pressure in Lb. per In. of Width.	Pressure per Sq. In. of Tooth Surface.	Pinion Tooth, Lb. per Sq. In.
	in.				
No. 12	0·2618	52·0	480	2,880	18,460
No. 6	0·5236	16·5	1,450	4,350	27,700
No. 4	0·7854	62·0	2,000	4,000	26,200

The figures in the last three columns are based on the assumption of one tooth per pinion in gear.

Worm Gearing.

The manufacture of worm gearing has been very highly developed for automobile purposes where a right-angle drive is required. Efficiencies up to 97 per cent. have been obtained. In designing worm drives the strength of the teeth need rarely be taken into account, wear is the principal factor, hence lubrication is of prime importance. It has been usual to keep tooth pressure × velocity of pitch line of worm constant, a practice sometimes followed in designing ordinary thrust bearings, but modern experience seems to show that within certain limits pressures may actually be increased as the worm speed increases. This applies to enclosed lubricated gears with ball thrust bearings. Phosphor-bronze wheels and steel worms is the usual combination. Mr. Lanchester designs his gear on the basis of 1 ton per square inch of projected wheel-tooth area, and states that an overload of two to three times this amount may be safely carried for short periods. The surface speed of the worm for these pressures is in the neighbourhood of 1,000 ft. per minute. The action of the lubricant seems to be similar to the action which obtains in a "Michel" bearing.

For efficient working a highly-polished worm is necessary, hence grinding is used to finish the worm. Chrome steel is sometimes used for worms, but if a sufficiently thick film of lubricant can be maintained between the surfaces of the worm thread and wheel teeth ordinary carbon steel should give good results.

The principal factor in worm efficiency is the worm-thread angle, the best angle being about 45 deg. High ratios of reduction are less efficient than low ratios, as, to obtain compactness of design, thread angles of low value must be used in order to keep the worm diameter within reasonable limits. Slow-speed worm gearing often wears rapidly owing to the film of lubricant between the tooth surfaces breaking down and allowing metallic contact to take place, even when pressures are comparatively low. An increase of speed sometimes results in improved wearing qualities and efficiency.

Some useful formulæ are appended.

Lead = pitch × number of threads.
a = angle of thread.

$$\text{Tan } a = \frac{\text{Lead}}{\text{circumference of worm}}$$

μ = angle of friction.

$$\text{Efficiency with worm driving wheel} = \frac{\text{Tan } a}{\text{Tan } (a+\mu)} \times \text{C.}$$

$$\text{Efficiency with wheel driving worm} = \frac{\text{Tan } (a-\mu)}{\text{Tan } a} \times \text{C.}$$

where C is a factor depending on the type of thrust bearing used. The angle of friction may be taken as 2½ deg. and C about 0·98 for a ball thrust and 0·94 for a collar thrust bearing.

Let A = pressure on teeth of worm at right angles to axis of worm.
B = pressure on teeth of worm wheel and also pressure on thrust bearing.

$$\text{Then A} = \frac{\text{H.P.} \times 33{,}000 \times 12}{\text{R.P.M.} \times \text{circumference of worm in inches.}}$$

$$\text{B} = \frac{\text{A}}{\text{Tan } (a+\mu).}$$

Boiling-Points at One Atmosphere and in a Vacuum.—In 1890, W. Herz and Ph. A. Guye, independently of one another, showed that the boiling-point, at a pressure of 1 atmosphere, when expressed on the absolute scale is approximately two-thirds of the critical temperature of the substance, and the boiling-point in a vacuum of about 20 mm. about half of the critical temperature. The ratio of the two boiling-points T_{20}/T_{760} should hence be a constant = 0·78. Examining this empirical relation, W. P. Jorissen (*Zeitschrift für Anorganische Chemie*, 104, pages 157 to 162, October 25, 1918) confirms the constancy for a great many substances, elements and compounds, mostly organic, and proves that it is a consequence of the vapour pressure laws as deduced by Van der Waals and others.

The Effect of Temperature on the Elasticity of Metals.—At the meeting of the Royal Society, held on February 6, Mr. A. Mallock, F.R.S., submitted a paper entitled, a "Note on the Elasticity of Metals as affected by Temperature." The note was an account of some preliminary experiments on the variations with temperature of Young's modulus for 15 selected metals. The choice was influenced largely by the ease with which specimens could be procured. No alloys are included. The metals chosen were rhodium, platinum, iron, palladium, nickel, copper, gold, silver, magnesium, aluminium, zinc, lead, cadmium, bismuth and tin. The procedure was to determine the frequency of the vibrations of a stiff rod carried at its lower end by a small thin plate of the material to be tested, the other end of the plate being clamped to a fixed support. The plate and its support could be immersed in fluid of any desired temperature without wetting the rod or in any way interfering with the mounting. The temperatures employed were those of liquid air, 0 deg. Centigrade, ordinary temperature (10 deg. to 15 deg.) and as near 100 deg. C. as was practicable. The measured frequencies of vibration at these temperatures furnished the necessary data for determining the changes in Young's modulus. The results showed that the more infusible the metal the less the modulus was affected for a given change of temperature, and this suggested that there might be a real connection between the variation of the modulus (M) and the melting-point θ_M in absolute temperature. A diagram was given comparing the experimental results with what they would have been had the relation $d\,M/d\,\theta = \theta_M$ been true. If this relation holds and $\theta_1\,\theta_2$ are two temperatures for which the moduli are $M_1\,M_2$, then would $M_1/M_2 = \theta_M - \theta_1/\theta_M - \theta_2$, and if θ_1 is absolute zero and $\theta_2 = 0$ deg. C., so that in this case $M_1/M_2 = \frac{\text{Melting-point absolute}}{\text{Melting-point Centigrade}}$ for any two temperatures differing by 270 deg. C. The experimental results show a distinct resemblance to those obtained on this supposition.

SCHOLARSHIPS FOR NAVAL ARCHITECTURE AND MARINE ENGINEERING.

The General Committee of "Lloyd's Register of Shipping," at their meeting last week, decided to resume the practice followed previous to the outbreak of war of granting scholarships for the study of naval architecture and marine engineering. In 1915, owing to the fact that many young men, who would otherwise have become candidates for these scholarships, were serving with His Majesty's Forces, ashore and afloat, and that the services of others were urgently required in the shipbuilding and marine engineering establishments throughout the country, it was arranged, with the concurrence of the universities, and other institutions, through whom the scholarships are given, that no further scholarships should be awarded pending the conclusion of the war.

The committee now consider it desirable that the examinations for these scholarships should be resumed, so that the successful candidates may be enabled to begin their studies at the several universities commencing with the autumn sessions this year. The 14 scholarships established by the Committee of "Lloyd's Register" are as follows :—

Three scholarships in naval architecture at each of the following universities, tenable for three years, viz. Glasgow, Durham, and Liverpool.

Three scholarships in marine engineering at the University of Liverpool, tenable for three years, and

Two scholarships in marine engineering in connection with the Institute of Marine Engineers, tenable for two years.

The committee, who have always taken a lively interest in the promotion of technical education in shipbuilding and marine engineering, desire to attract the best talent to the industries, and with this object have amended the regulations governing the scholarships in order that the field of competition for the scholarships may be considerably widened.

Prior to 1915, five "Lloyd's Register" scholarships were competed for each year, and they were of a value of 50*l.* per annum; but the committee have resolved in existing circumstances to increase this amount to 100*l.* per annum for the present, and, in view of the fact that no scholarships have been awarded during the past three years, and also that probably there will be a larger number of candidates offering themselves than has hitherto been the case, the committee are prepared to authorise the grant of more than one scholarship to each Institution for the present year, provided the responsible authorities are in a position to recommend that, in view of the competition, and of the satisfactory qualifications of the candidates, such a course might be adopted with advantage.

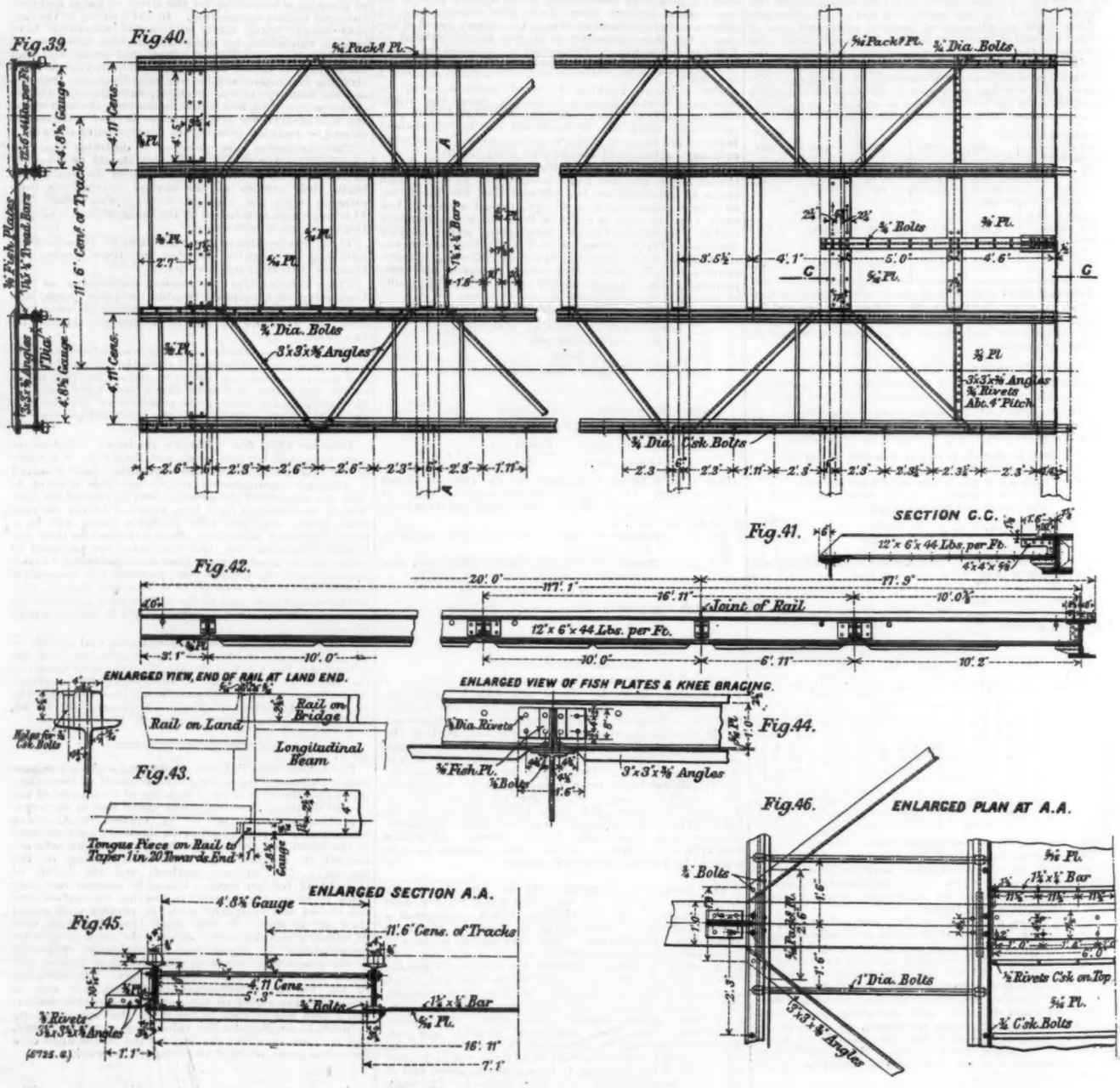
Full particulars of the qualifications and details of the subjects of examination can be obtained from the following: The Clerk of Senate, University of Glasgow; the Registrar, University of Liverpool; the secretary Armstrong College, Newcastle-on-Tyne; and the Secretary, Institute of Marine Engineers, 85 to 88, The Minories, Tower Hill, London, E. 1.

Education for Foreign Commerce.—At a congress held in Atlantic City in the commencement of December, under the direction of the Chambers of Commerce of the United States of America, it was stated that in the larger opportunities which are to be opened to American business men to play a part in the international commerce of the world, the need will be felt for more men who are trained to a knowledge and understanding of the languages, the business methods and the habits of thought of foreign lands. Complete success can only come to those who succeed in putting themselves into full accord and sympathy with the peoples with whom they are to deal. It was urged that American men of industry and commerce should take steps to provide opportunities for young men to obtain an education in the practices of overseas commerce and finance and in the practical use of foreign languages. The attention of the various departments of Government and of educators was called to the importance of this matter, and a plea was entered to the effect that special efforts be made to supplement the valuable work already done, and to open up every facility for the furtherance of a successful prosecution of this educational work.

Agricultural and Dairy Machinery. — The Minister of Munitions has suspended as from the 14th inst. until further notice the Agricultural Machines, Implements and Vehicles (Manufacture) Order, 1917, and the Agricultural and Dairy Machines, Implements and Vehicles (Sale) Order, 1918. The effect of the suspension of these orders is that any person may now manufacture agricultural and dairy machines and implements without first obtaining a permit from the Agricultural Machinery Department of the Ministry of Munitions. In addition the regulations restricting the prices at which such machines and implements can be sold either by manufacturers or agents are suspended, and it is no longer necessary for any manufacturer to make application to the Agricultural Machinery Department of the Ministry of Munitions for permission to advance his prices. The suspension of the Orders has been agreed to by the Minister of Munitions after taking into consideration an undertaking given by the principal manufacturers that they will do everything possible to safeguard the adequate supply of all agricultural and dairy machines, implements, and spare parts to meet the requirements of the United Kingdom and to make provision for the expeditious delivery of all such home requirements before dealing with export demands.

THE SOUTHAMPTON TRAIN FERRY; DETAILS OF TRAIN FERRY BRIDGE.

CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.



THE SOUTHAMPTON TRAIN FERRY.

(*Concluded from page* 120.)

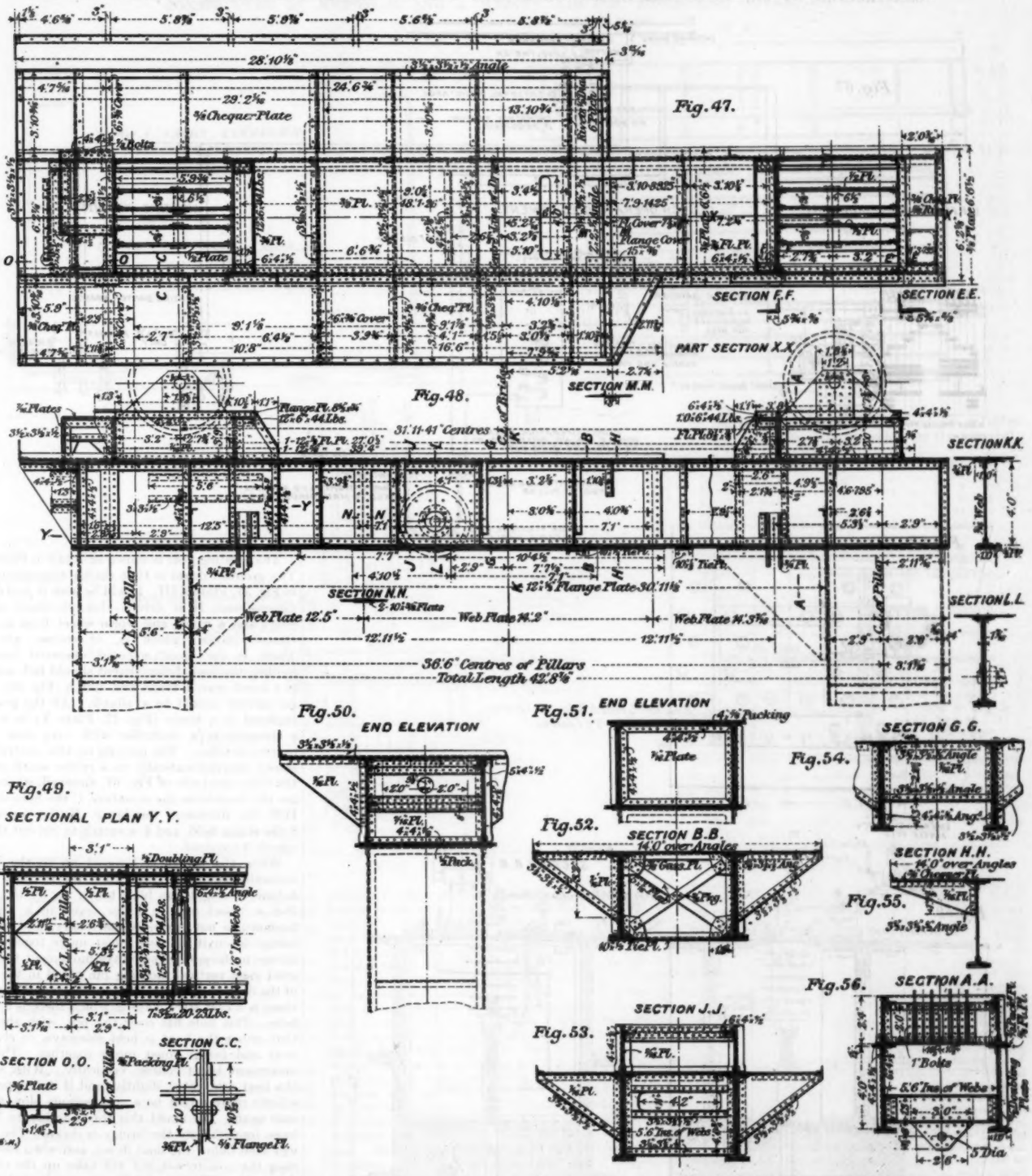
In our issues of January 17 and 24 we gave drawings and particulars of the vessels employed in the service of the Southampton train ferry, together with an account of the purposes for which the ferry was instituted. In our issue of February 7 we published general drawings of the ferry bridge by which the difference of levels of the jetty and the steamer, due to the 14 ft. rise and fall of the tide, are accommodated, so that locomotives and trains may pass from one to another over a hinged structure, the inclination of which varies to suit the requirements of the moment. In our present issue (Plates XII and XIII) we present detail drawings of the structure.

Figs. 17, 18 and 19, Plate X (Feb. 7), show that the ferry bridge is hinged at one end to a pier, and that near the other end it is supported by slings and wire ropes connected to winding tackle carried above by a cross frame supported on two steel towers. The length of the bridge is 122 ft. 6 in. (Figs. 21 to 25, Plate XII), and it is built with vertical and diagonal members, the scantlings, with enlarged sections at points, being shown in the engravings. The deck, which is 3 ft. 4 in. below the top of the upper booms, is carried on cross girders spaced 10 ft. centre to centre. It is important that a bridge of this description should be exceedingly elastic, since it has to connect a rigid shore pier with a vessel which may have a list, and which may alter its position as it is being loaded. To allow for this the cross-girders are hung from pins in the main verticals of the girders (Fig. 19, Plate X), and the girders themselves are connected by light bracings (Figs. 34 and 35, Plate XII). The deck and its bracings are shown in Figs. 39 to 46, on the present page, and the whole bridge is designed to provide for three conditions of loading: (1) Two trains abreast of each other, the wagons being 28 ft. 2 in. in length over the buffers, 12 ft. 3 in. wheel base, and weighing 30 tons each, headed by a six-coupled shunting locomotive, having a 12-ft. wheel base, 6-ft. centres of axles, and the weight of 48 tons distributed equally over all three axles; (2) a locomotive and tender on one track only, 62 ft. 3 in. over buffers, and weighing (light) 122 tons; (3) a 12-in. gun on one track only on railway mountings. With any of these loads a variation of 24 in. in level between the two ends of the girders on the boat is permissible. As the distance between the centres of the two main girders is 24 ft. 11 in., this is not a very serious distortion in view of the elastic construction of the bridge.

The bridge is normally suspended by wire ropes

THE SOUTHAMPTON TRAIN FERRY; DETAILS OF TRAIN FERRY BRIDGE.

CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.



at a point 21 ft. 3 in. from its far end, as shown in Figs. 17 to 19, Plate X (issue of February 7). For this purpose there are two steel pillars erected upon masonry supports, and connected by strong cross-girders (Fig. 19, Plate X). Details of the pillars are given in Figs. 37 and 38, Plate XII, and details of the cross-girders in Figs. 47 to 56, annexed. It will be seen that the pillars are of box section (Fig. 37, Plate XII), and that they have brackets at the bottom to increase the bearing area, and at the top to secure the cross-girders. The general scheme of the lifting appliances is shown in Fig. 19, Plate X, in which it will be seen that lifting brackets, shown in detail in Figs. 30 to 32, Plate XII, are attached to the upper booms of the girders (Fig. 23, Plate XII), and that pinned to these are vertical rods which are united by a triangular frame. The base member of this frame (Fig. 19, Plate X) is fitted with rubbing blocks of hard wood working in vertical guides in the inner faces of the two pillars (see enlarged section in Fig. 37, Plate XII).

There are two means by which the bridge can be suspended. First it may be immobilised by two steel rods, hinged at the top to the cross-girders, and connected by pins to lugs on the triangular frame. These rods can be seen hanging loose in Fig. 19, Plate X. Their purpose is to allow the wire ropes to be cast loose for repairs and overhaul. For daily work the triangular frame (Fig. 19) carries four sheaves (Fig. 57, Plate XIII), around which are eight falls of rope carrying 124 tons. The disposition of the ropes is shown by the engravings on Plate XIII. Each dead end is fitted with an eye, and this is connected by links and adjusting screw to a cross member of the girders (Figs. 61 and 62). The rope is then led over a jockey pulley, 3 ft.

THE SOUTHAMPTON TRAIN FERRY; DETAILS OF TRAIN FERRY BRIDGE.

CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEERS, NEWCASTLE-ON-TYNE.

Fig. 67.

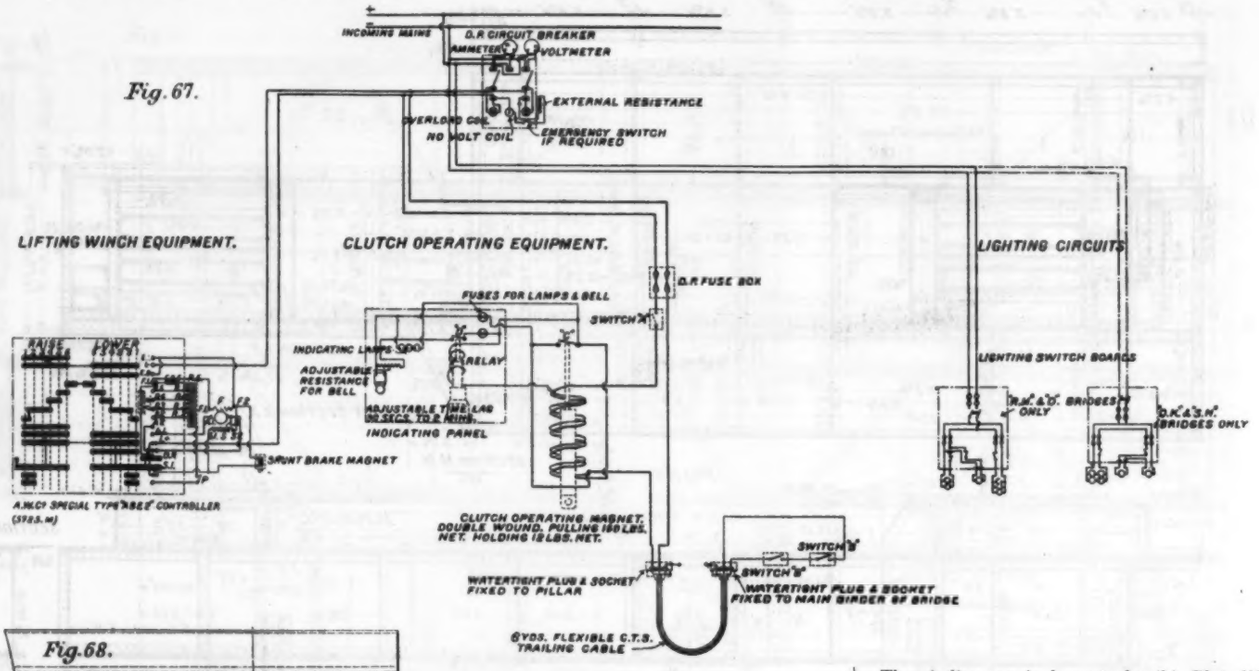


Fig. 68.

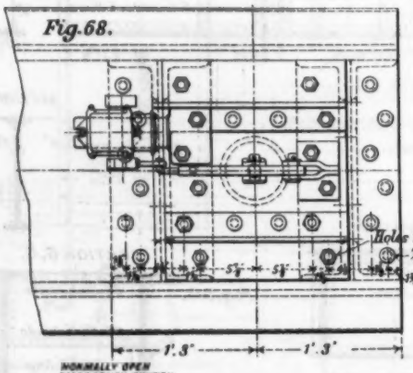


Fig. 69.

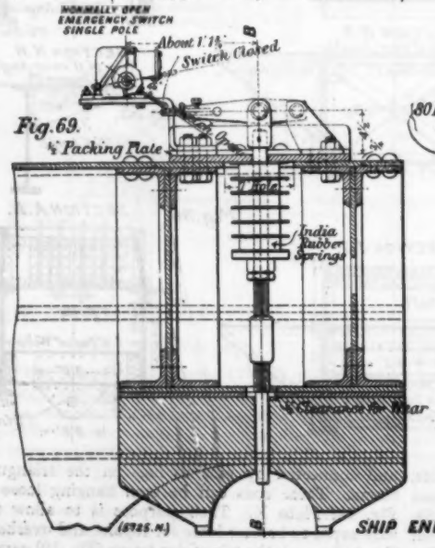
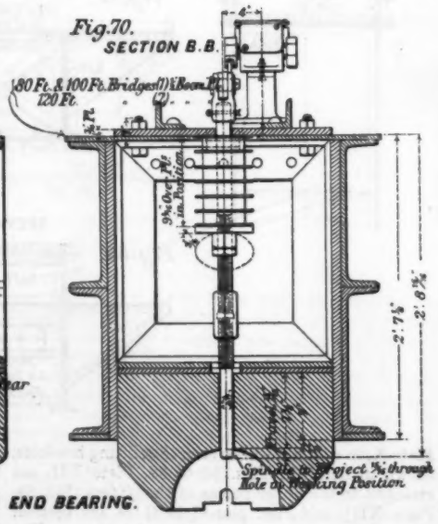


Fig. 70. SECTION B.B.



SHIP END BEARING.

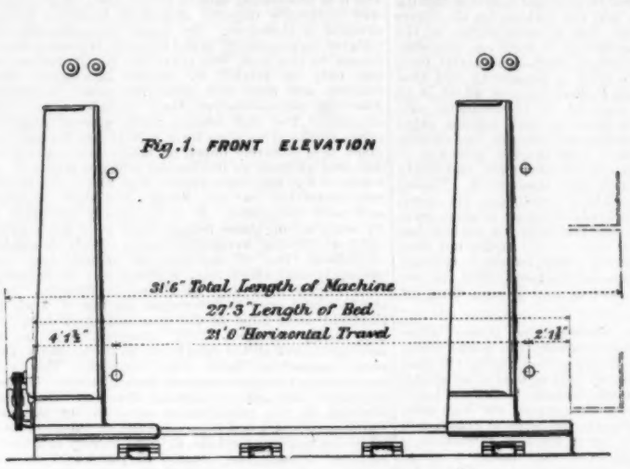
in diameter, over the tread, down to one of the sheaves. It passes round the sheave and then upwards to a driven drum around which it is wound 2¼ or 2½ turns, finally passing right or left to a jockey pulley, and thence down the centre of the pillar to a counterweight of 28 tons. There are two ropes for each counterweight, and there is an unbalanced weight of 10 tons to maintain contact between the bridge and the vessel. Adjusting screws and equalising bars are provided at each connection to divide the load evenly between the various ropes.

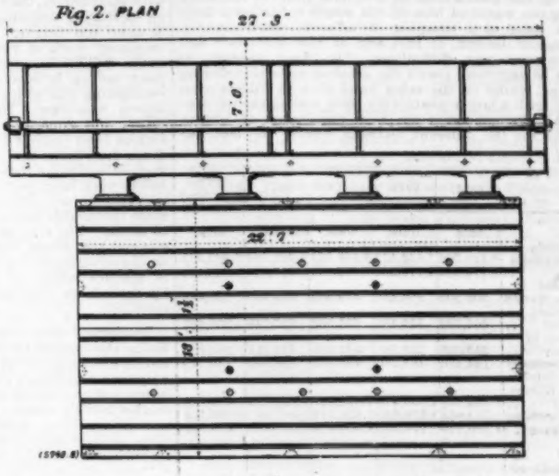
The winding gear is shown in detail in Plate XIII. The grooved drum is that shown diagrammatically in Fig. 57, Plate XIII. It will be seen it is of massive dimensions. It is driven through three pairs of gears and a worm and worm-wheel from a 20-h.p. electric motor, which is, of course, reversible. There is the usual solenoid operated brake for holding the gear if the current should fail, and there is a hand gear, a brake and clutch (Fig. 66) in case no current should be available. All the gearing is enclosed in a house (Fig. 17, Plate X) in which is a tramway-type controller with very slow speeds on two notches. The circuits on this controller are shown diagrammatically to a rather small scale on the right-hand side of Fig. 67, annexed, where A^1 A^2 are the brushes on the armature, C the blow-out coil, D R the discharge resistance, F the series field, S the shunt field, and P a switch to cut out the slow speeds if required.

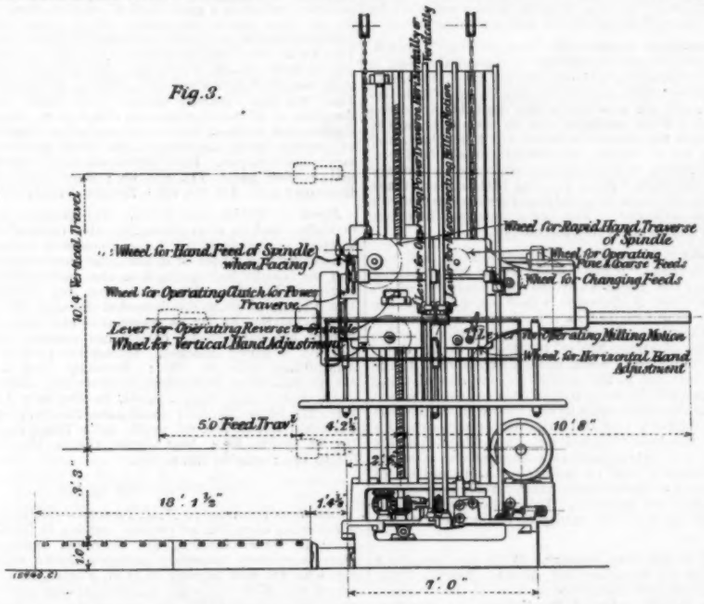
When the bridge is lowered on to the boat it naturally comes to rest when its 10 tons of unbalanced weight has been taken up by the vessel. But a vessel on the water, even in a protected harbour, is not perfectly stationary, and once the bridge is on it the two must move together. To secure uniformity of sideways movement there is a solid steel vertical mooring pin fitted in the centre of the deck at the stern, and on the end of the bridge there is a cast steel plate in which there is a slotted hole. This hole fits over the pin, with the result that either the boat is held sideways, or else both boat and bridge must move together. The chief movement is, of course, vertically. With no load the boat may pitch slightly, and if it dropped only a little there might be a very serious blow when it rose again. To avoid this the gear has to be cast loose immediately the bridge is down. The bridge will then follow the boat down, and when the vessel rises the counterweights will take up the slack in the ropes. There are two means by which the clutch can be withdrawn from the motor, one by hand and the second automatically, as shown in Fig. 67, annexed. In the centre of the figure A is a switch, mounted on a panel alongside the controller. It is hand-operated, normally closed and self-resetting. Switch B is on the end of the bridge, and is shown in details in Figs. 68 to 70, on page 240. It is contained in what are called "elephant feet." These have half-spherical cups which fit over corresponding knobs on the deck. When they get home the spindle in the centre is

HORIZONTAL DUPLEX BORING, DRILLING AND TAPPING MACHINE.

CONSTRUCTED BY MESSRS. G. AND A. HARVEY, LIMITED, ENGINEERS, GOVAN.







All gears are cut from the solid and are entirely protected by guards. The following are the principal dimensions of the tool :—

	Ft.	In.
Length of bed	27	3
Breadth of bed	7	0
Depth of bed	1	6
Horizontal range of spindle	21	0
Vertical travel of spindle	10	0
Lowest position of spindle from top of table	2	0
Feed travel	5	0

Feeds: 8, 12, 16, 24, 32, 40, 60, 80, 120, 160 per inch.

Speeds of spindle :—

Through chuck gearing and treble gearing in base, 0·75 r.p.m. to 2·25 r.p.m.
Through chuck gearing and double gearing in base, 2·25 r.p.m. to 6·75 r.p.m.
Through chuck gearing and single gearing in base, 6·75 r.p.m. to 2·25 r.p.m.
Through spindle sleeve gearing and treble gearing in base, 2·5 r.p.m. to 7·5 r.p.m.
Through spindle sleeve gearing and double gearing in base, 7·5 r.p.m. to 22·5 r.p.m.
Through spindle sleeve gearing and single gearing on base, 22·5 r.p.m. to 67·5 r.p.m.

The above six maximum and minimum speeds have each at least 18 intermediate speeds due to steps on the starter of the variable-speed motor, of which the range variation in speed is 1 to 3.

Work table dimensions ... 22 ft. 6 in. × 13 ft.
Weight, approximate ... 70 tons.
Floor space, occupied ... 31 ft. 6 in. × 24 ft.

pressed up against a powerful rubber spring, and trips a switch which sends a current to the solenoid shown in Fig. 67. The plunger rises and opens the switch C, inserting a thin winding and a relay winding in series with the pulling winding. The bell rings and the lamps light until the relay plunger rises after a time determined by the time lag. The relay switch then opens and the bell stops. To insert the clutch the hand switch A is opened, the plunger of the double-wound magnet and relay falls and the cycle is ready to be repeated.

The ferry bridge and the vessel were designed and constructed by Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, of Newcastle-on-Tyne, in association with the staff of the Inland Waterways and Docks Branch of the War Office.

HORIZONTAL DUPLEX BORING, DRILLING AND TAPPING MACHINE.

On this page, and on page 244, we illustrate a large horizontal boring, drilling and tapping machine, constructed by Messrs. G. and A. Harvey, Limited, Govan, Glasgow. An end view of the machine showing the principal dimensions is reproduced in Fig. 1, above, whilst other particulars are shown in Figs. 2 and 3. The general appearance of the tool is, however, perhaps best shown by Fig. 4, page 244, which gives a good idea of its massive character. The spindles are 6 in. in diameter. The design is such that both spindles can be used on a single piece of work or on separate jobs, as may be required, the two heads being absolutely independent of each other. A noteworthy feature is the very large range of spindle speeds provided for. These speed changes are effected in part by gears in the sole and in the saddle of the standards, and in part by the use of variable speed motors, the machine being electrically driven. The spindle can be instantaneously reversed, enabling the tool to be used for tapping and studding. The bed is of a strong section, and provides broad and accurately-machined ways in which the standards slide. The work table is firmly secured to this bed, and the tee slots in it are planed from the solid. The standards are of box section, and can be moved by power in either direction along the bed, hand gear being provided for effecting the final adjustment of position. The power traverses are controlled from the saddle, and each standard is, of course, independently movable. The saddles are balanced and fitted with hand and power traversing gear. Ball thrust washers have been fitted where necessary. The spindles are of hard forged steel and are ground to fit their sleeves. The bearings in which the latter revolve are of hard gun-metal. The reversing gears are of hard steel and are operated by levers in front of the saddle. The feed is positive, and can be rapidly and easily started, stopped or changed. The drive is furnished by variable-speed motors, of which one, of 20 h.p., is mounted on the sole of each standard. These motors drive, through a gear box, the vertical shaft by which the motion is conveyed to the spindle and operating gears on the saddle. The motors are designed to work with direct current supplied at 500 volts. They are of the enclosed, variable-speed, ventilated type, and were constructed by the Lancashire Dynamo and Motor Company.

RUSSIA'S PRODUCTION OF PLATINUM.—From statistics compiled by Albert R. Merz, of the Bureau of Soils, Washington, U.S., and published in the November issue of *The Journal of Industrial and Engineering Chemistry* (pages 920 to 925), we see that the discovery of platinum in the Ural dates from 1823. Previously the State of Colombia, South America, had supplied the platinum of the world, about 16,000 oz. annually. To promote the Russian platinum mining, platinum coins were adopted in 1828, and by 1843 some 112,000 oz. were produced annually, 453,000 oz. having altogether been coined. The Government then discontinued the platinum mining, withdrew the old coins, and allowed the so-far interdicted export of platinum. In 1862 the Russian Treasury sold all its stocks of this metal to Messrs. Johnson and Matthey, and by the end of the past century the annual production reached 190,000 oz. Foreign firms more and more controlled the industry; however, prices fluctuated much, the independent producers were discouraged, and in this century the total platinum production has had a downward tendency. It was 157,000 oz. in 1913 and 1914, and went down to nearly 120,000 oz. in 1915. In the Ural the platinum beds are restricted to a very limited area; the beds are alluvial and consist of placers which are also auriferous and associated with certain olivine rocks known as dunite. In recent years the Verkhotur and Perm districts have become more important. At the outbreak of the war the Nishne Tagel and Isov districts were the chief platinum sources. The refining of platinum is almost entirely in foreign hands, the chief firms being Johnson, Matthey and Co., of London, Herneus and Co., of Hanau, and the Société d'Industrie du Platine, in Paris. In December, 1913, the Russian Government once more prohibited the export of crude platinum and started refining in Russia; this law fell hard on some Russian producers, however, and was considered to be in conflict with international agreements, so that an export *ad valorem* duty of 30 per cent. was to be passed after July, 1915.

GERMANY'S PRODUCTION OF STEEL AND IRON DURING THE WAR.

SOME official statistics have now been made available showing the production of steel and iron in Germany during the war, and how on the whole it has been kept up in spite of a complex of adverse circumstances, shortage of labour, of fuel and of raw materials and chronic transport difficulties. The Saar district, as might be expected, shows the greatest reduction during the war, whilst on the other hand that of Silesia even figures with a larger production than during the pre-war period. We append a list with particulars of output of steel for the different districts during the last five years :—

	1914.	1915.	1916.	1917.	1918. (10 Mos.)
	tons.	tons.	tons.	tons.	tons.
Rhineland-Westphalia	8,420,706	7,642,122	9,165,033	9,363,066	7,827,961
Silesia ..	1,173,068	1,170,263	1,402,809	1,459,523	1,226,174
Siegerland, Hessen, Nassau	306,399	296,439	339,505	323,937	255,463
North-East Central ..	604,793	543,454	694,522	917,248	808,623
Kingdom of Saxony ..	259,095	263,580	342,898	419,212	360,678
South Germany	144,126	164,732	152,363	208,304	185,919
Saar district and Rhine-palz ..	1,390,248	1,050,475	1,319,847	1,267,298	1,012,185
Alsace-Lorraine	1,513,844	1,178,230	1,456,113	1,547,107	1,223,193
Luxemburg ..	1,160,229	978,759	1,309,429	1,081067.	856,707
Total in millions of tons ..	14·97	13·26	16·18	16·59	13·76

The figures for 1918 only cover the first ten months.

As regards the manufacture of the different kinds of steel the war naturally has wrought some material changes owing to the special demands for military purposes. It will be noticed that the production of electro-steel and steel castings shows a considerable increase :—

	Tons.	Tons.	Tons.	Tons.	Tons.
Thomas steel ..	8,169,183	6,529,285	7,653,990	7,294,899	5,906,460
Siemens-Martin steel ..	6,220,536	5,672,013	6,856,801	7,274,473	6,170,781
Bessemer steel	100,617	104,570	175,109	175,430	146,424
Crucible steel	93,096	100,578	108,295	129,784	79,064
Electro steel ..	89,636	131,579	190,036	219,700	221,824
Steel castings	298,338	660,029	1,198,379	1,495,074	1,232,260

The production of pig-iron shows very considerable fluctuations during the war, not only from year to year, but from month to month. It has caused some surprise, that the production during 1917, and also during the first half of 1918, was on a larger scale than during any earlier period of the war. The following table shows the production in millions of tons for every month for the past seven years, illustrating the tremendous reduction following in the wake of the war and also the baneful influence of labour conflicts and disturbances :—

—	1912.	1913.	1914.	1915.	1916.	1917.	1918.
January ..	1·387	1·611	1·567	0·874	1·078	1·083	0·434
February ..	1·338	1·494	1·456	0·803	1·037	0·944	0·893
March ..	1·448	1·629	1·603	0·938	1·114	1·104	1·039
April ..	1·453	1·588	1·534	0·939	1·073	1·131	1·085
May ..	1·494	1·643	1·607	0·986	1·113	1·198	1·185
June ..	1·454	1·609	1·531	0·990	1·079	1·125	1·183
July ..	1·577	1·648	1·564	1·048	1·133	1·190	1·180
August ..	1·550	1·640	0·587	1·051	1·145	1·186	1·155
September ..	1·553	1·591	0·580	1·034	1·116	1·120	1·105
October ..	1·570	1·653	0·730	1·076	1·161	1·076	1·049
November	1·538	1·589	0·789	1·019	1·101	1·008	—
December ..	1·567	1·611	0·854	1·029	1·102	0·977	—
Million tons	1·787	1·931	1·440	1·179	1·325	1·314	about 12·0

It will be interesting to see the figures for the first months after the revolution, and still more how the German steel and iron industry will manage after the loss of Alsace-Lorraine and the severance of the connection with Luxemburg.

THE FINANCING OF OILFIELDS.—According to Mr. Montagu Summers, who read a paper on "The Financing of Oilfields" before the Institution of Petroleum Technologists last Tuesday, the capital invested in oil enterprise during the last fifteen years in this country amounted to 125,000,000*l.*, whilst the actual market value of the existing companies would be 250,000,000*l.* ; in America, some 380,000,000*l.* were so invested. These figures did not comprise oil shales and pipe lines nor allied industries. In Mexican oilfields alone America and England had together invested nearly 62,000,000*l.*, 20,000,000*l.* of this being English capital. In 1901 the oil production of Mexico was only 10,345 barrels ; in 1917 it amounted to 55,293,770 barrels. The United States Geological Survey estimated the total world's production of crude oil up to 1917 at 6,983,567,246 barrels of 42 gallons ; the year 1917 alone produced 503,708,000 barrels. The paper was of a very general kind, and did not give any detailed financial information at all, nor did the lecturer explain which part of the industry required the main share of financing. He advocated joint action of the Government with companies, as in the case of the Anglo-Persian Oil Company.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—While the steel works which are still in operation are fully employed and well booked up with good orders, the labour trouble and unrest is causing an increasing uneasiness, and the outlook for the future is none too bright. That this is detrimental to the necessary work of reconstruction is only too palpable, as the diffidence of consumers to purchase material, or to place orders, is decidedly fatal to prosperity and that broadening out which was looked for, and which is an urgent necessity. The removal of Government subsidies, the American competition, and various other factors tend further to complicate matters, but despite these drawbacks the work in hand is quite sufficient to keep things going for some considerable time, and surely before very long matters will right themselves. Taking everything into account, labour conditions are much more favourable to the workers than some of them seem to think. The trouble among the shipyard workers has stopped the steady flow of steel to the yards, but this, on the other hand, has released a quite extensive tonnage of manufactured and semi-manufactured steel for use by consumers who have had to wait a long time for supplies.

Malleable Iron Trade.—Shortage of labour alone limits the output from the malleable iron works where orders are as plentiful as at any period during the past 4½ years. Although the heavy cost of bars of all grades is not yet conducive to much overseas trade, the home market readily absorbs the entire output, the high price notwithstanding. Undoubtedly the boom in export will come immediately that a lower level is announced—meantime would-be consumers are constrained to adopt a "wait and see" policy. Having been unaffected by the strike, the outputs are being well maintained.

Scotch Pig-Iron Trade.—The demand for pig-iron, although not perhaps so feverish as during the war, is steady and progressive, with outputs on a very extensive scale. Foundry grades are scarce, forge is more plentiful than it was, and all over the better qualities are much sought after. With subsidies due to terminate at the end of April, a big change in price will take place, and this fact is, to an extent, restricting certain business, as both producers and consumers are somewhat chary of any forward deal. Even yet but little export trade is being done, although the granting of licences to neutrals is much less stringent. The home markets, however, find no difficulty in absorbing the output.

Development of Bowling Harbour.—This scheme, mentioned in these "Notes" some weeks ago, is taking definite form, the Anglo-American Oil Company, which proposes to erect a riverside wharf or dock for the discharge of steamers, and as a coal bunkering station for ships sailing from the Clyde, having decided to sell a river frontage of about 330 ft. to Messrs. Scott, Shipbuilders, Bowling, for a much-needed extension. While favourably disposed to the scheme, which should bring much prosperity in its train to the little township, which has had an honourable and historic record in connection with Clyde shipping and shipbuilding for upwards of a century, the Landward Committee of the Old Kilpatrick Parish Council is determined to safeguard the interests of the inhabitants, and to maintain the amenities of the district, and with this end in view, certain restrictions will most likely be imposed. These, however, should prove no detriment to the utility or the success of the scheme.

Launch of a Standard Steamer.—With the launch of the War Ajax on Saturday last, Messrs. Barclay Curle and Co., Limited, have completed another of the standard vessels built to the order of the Shipping Controller. A twin-screw steamer, 450 ft. in length, 58 ft. 2 in. in breadth and 37 ft. 1 in. in depth, the new vessel will have triple-expansion engines supplied by the builders.

THE YORKSHIRE ELECTRIC POWER COMPANY.—Speaking at the annual meeting of the proprietors, held in Leeds last Tuesday, Mr. Arthur G. Lupton, the chairman, said the company was achieving success after a tedious period of probation. The original shareholders had had long to wait for a reasonable return on their capital, but the confidence which induced them to form the company was now being justified, and if the latter were allowed to continue the work with which it was originally entrusted, without further legislative interference, it would continue to grow and to render steadily increasing services to the West Riding, which it was constituted to serve. The company, he added, was taking every means in its power to impress upon the Government the urgent need for speedy decision as to the future of the industry, so far as generation was concerned, and negotiations had been entered into which, it was hoped, would lead to a satisfactory solution. To construct a station, such as the company contemplated at Ferrybridge, was a matter of years and the demands for power were so immediately urgent that delay in putting the buildings in hand and placing orders for plant was extremely grievous. The mutual supply arrangements, which the company had been able to carry through with Bradford, Mexbro', Rotherham and Sheffield, were important. The large additions to the stations at Thornhill and Barugh were almost completed and the large-sized units were giving great advantage in economy and efficiency. This was assisted by improved arrangements for coal handling, and if the company were allowed to develop on normal lines there was every reason to anticipate for it a satisfactory, profitable and useful future.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The task of attuning war-time production to peace-time conditions is necessarily slow, but it is proceeding satisfactorily, and, when completed, will materially improve output in branches where the demand is strongest. On works managements largely falls the responsibility of devising the necessary ways and means to this end, but there are considerations which can only be settled by mutual agreement between masters and men, and these are under discussion at meetings representative both of labour and capital interests. For this reason, while general approval is given to the scheme to form a National Labour Parliament, it is sincerely hoped on both sides that the establishment of such an institution will not result in, or be followed by, any interference with the Joint Boards of representatives in the South Yorkshire engineering and steel industries. It is commonly admitted that, by negotiation, these boards have been the means not only of effecting wonderful improvements in conditions of labour, but of accelerating output and dealing promptly and effectively, without loss to industry on either side, with any questions in dispute. Despite the fact that over 13,000 people are out of work in the Sheffield area, most of the iron and steel departments are busily engaged. Tool manufacturers are quite unable to meet all the calls made on their output, though more operatives have been engaged. This applies particularly to engineering and farming tools. Gardening requisites are also in strong demand. Departments devoted to the manufacture of steel for the motor-building industry and tramway steel are busily employed, while for railway steel the demand is very fair on home account, though the volume of purchases on export account indicates a good deal of caution, due, probably, to the high prices obtaining. High speed twist drills will continue at the prices arranged in March of last year. The Twist Drill Manufacturers' Association's reason for this is that advances in wages and working costs more than counterbalance the reduction in the price of steel. The pig-iron market shows very little movement. Supplies of all descriptions are different to obtain. The market for finished bars is in a similar condition, and at present there appears to be little prospect of an augmented output. Steel billets are firm at the following rates :—Soft basic, 11*l.* 12*s.* 6*d.* ; hard basic, 10*l.* 15*s.* ; Bessemer acid, 15*l.* 2*s.* 6*d.* ; Siemens' acid, 15*l.* 12*s.* 6*d.*

South Yorkshire Coal Trade.—The pressure for manufacturing fuel is, if anything, greater than a week ago. Output is reported to have increased slightly, but practically the whole of it has gone into industrial use, and no benefit has accrued to the open market. The house coal section does not show any improvement. The advent of snow has impeded delivery and has not helped matters so far as merchants and domestic consumers are concerned. Slacks are moving freely and coke is a sound market. Quotations :—Best branch handpicked, 27*s.* to 28*s.* ; Barnsley best Silkstone, 27*s.* to 27*s.* 6*d.* ; Derbyshire best brights, 25*s.* to 26*s.* ; Derbyshire house coal, 22*s.* 6*d.* to 23*s.* 6*d.* ; best large nuts, 22*s.* 6*d.* to 23*s.* 6*d.* ; small nuts, 21*s.* 6*d.* to 22*s.* 6*d.* ; Yorkshire hards, 22*s.* 6*d.* to 23*s.* 6*d.* ; Derbyshire hards, 21*s.* 9*d.* to 22*s.* 9*d.* ; best slacks, 18*s.* to 19*s.* ; seconds, 16*s.* to 18*s.* ; smalls, 13*s.* to 14*s.*

CHEMISTS SERVING IN H.M. FORCES.—With the object of assisting chemists at present serving in H.M. Forces on their demobilisation, the Chemical Industry Club offers temporary honorary membership to officers and men who are now serving in H.M. Forces, or who have served and have not since entered civilian employment, who are approved by the committee as having the requisite status as chemists ; such membership to date from their election and to continue for a period of three months, which may be extended at the discretion of the committee.

DIESEL ENGINE USERS ASSOCIATION.—Mr. Napier Prentice, A.I.E.E., engineer and manager to the Suffolk Electricity Supply Company, Limited, has been re-elected president of the Diesel Engine Users Association for the current year, and Mr. Percy Still, M.I.E.E., chief engineer and manager to the Chelsea Electricity Supply Company, Limited, has been re-elected honorary secretary. The association was founded in 1913, and in his annual report the hon. Secretary referred to the rapid growth of its membership which now includes about 200 subscribers. As this includes several members scattered over the greater part of the world and who cannot possibly attend the meetings, it is evident that the reports of proceedings and other information circulated by the association are appreciated and found useful. In consequence of war-time conditions the use of tar oil as a home product suitable for fuel in Diesel engines became recently a matter of importance and urgency, and several meetings during the past year were taken up with the consideration of questions concerned with the qualities of tar oil most suitable for the purpose, and various methods of burning tar oil in Diesel engines. The Heavy Oil Engine Fuel Committee, consisting mainly of members of the Diesel Engine Users Association, was formed in January, 1918, to assist the Mineral Oil Production Department of the Ministry of Munitions in the control and distribution of supplies of fuel oil, and in arranging as far as possible to substitute tar oil fuel in place of imported petroleum fuel oil. The last two meetings of the year were taken up with the consideration of the subject of "Semi-Diesel Oil Engines," and as a result a very considerable amount of valuable information was collected and published in the reports of proceedings of the association.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Demand for Cleveland pig-iron continues heavy, and but for the inadequate supply of foundry pig-iron, the quality is in most request, a much larger business would be passing. As it is, even needs of home consumers of foundry iron cannot be met, and the British Dominions and neutral countries are clamouring for supplies. Interest has centred considerably in visits this week of pig-iron customers from Denmark, Sweden and Norway, whose efforts to place orders for those countries, however, have been unsuccessful. The visitors readily realised that none of the quality of iron they needed was available for neutral trade. At the same time merchants here hope that circumstances will permit renewal of transactions with Scandinavian customers at no very distant date, especially as those countries are now placing pig-iron orders in America. No difficulty whatever is now experienced in obtaining export licences for Cleveland pig-iron, and the only obstacle to foreign trade is the scarcity of the class of iron required. Forge pig-iron continues plentiful, and is selling freely for all purposes for which it can be used. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry and No. 4 forge are all quoted 95*s.*, and No. 1 is 99*s.*; whilst for export, No. 3 and the lower qualities are 145*s.* and No. 1 is 150*s.*

Hematite Iron.—The position as regards East Coast hematite may be regarded as fairly satisfactory. Supply for home purposes is more than ample, but permits for shipment abroad are still very difficult to secure, with the result that foreign trade is practically at a standstill. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use and 172*s.* 6*d.* for export.

Furnaces in Operation.—The number of blast furnaces in operation in this district at present is 71, of which 32 are making Cleveland pig-iron, 22 are producing hematite and 17 are manufacturing special kinds of iron. Two idle furnaces are likely to be restarted in the near future.

Coke.—Possibly the supply of coke is slightly less scarce than it has been, but deliveries still fall far short of what could be wished. Stocks of local consumers are very low. Average blast-furnace coke is 33*s.* at the ovens, and low phosphorus sort 35*s.* 6*d.* at the ovens.

Manufactured Iron and Steel.—Great activity characterises finished iron and steel. Works are very busily employed, and manufacturers have excellent order books. Notwithstanding labour troubles, shipbuilders are taking regular supplies of material, and home deliveries of other descriptions are large, whilst export trade shows expansion. Orders are coming forward from the Allies, the British Dominions, Spain, Holland, Scandinavia, and the Far East. Japan in particular is making very heavy inquiries. Prospects are thus bright. The following are among the principal market quotations to home customers:—Common iron bars, 16*l.* 5*s.*; steel ship, bridge and tank plates, 14*l.*; steel ship angles, 13*l.* 12*s.* 6*d.*; steel boiler plates, 15*l.*; chequer plates, 15*l.* 10*s.*; steel joists, 13*l.* 12*s.* 6*d.*; heavy steel rails, 13*l.* 10*s.*; and billets and blooms, 11*l.* 2*s.* 6*d.* to 12*l.* 15*s.* Export quotations include:—Bars, 20*l.*; steel ship, bridge and tank plates, 16*l.* 10*s.*; steel boiler plates, 17*l.* 10*s.*; chequer plates, 18*l.*; steel joists, 16*l.* 2*s.* 6*d.*; heavy steel rails, 15*l.* 10*s.*; and billets and blooms, 13*l.* 10*s.* to 15*l.*

CARTRIDGE BRASS, GRAIN SIZE AND HARDNESS.—An account of a series of experiments on a "Comparison of Grain-Size Measurements and Brinell Hardness of Cartridge Brasses" was presented by W. H. Bassett and C. H. Davis, of the American Brass Company, Waterbury, Connecticut, to the February meeting of the American Institute of Mining Engineers. Two alloys, both regular mill stock, were studied. The first had the composition: 69·20 per cent. of copper, 30·76 zinc, 0·02 lead, 0·02 iron; the brass had been rolled down from 0·58 in. to 0·376 in. The second brass had the composition 68·48 copper, 31·47 zinc, 0·02 lead, 0·03 iron; it was rolled down to 0·325 in., 0·273 in., 0·213 in., 0·168 in. the reductions in thickness amounting to 59 per cent., 50·9 per cent., 36·9 per cent., 20·2 per cent. Specimens were annealed for half-an-hour each time at temperature intervals of 50 deg. C., between 200 deg. and 850 deg. C.; between 275 deg. and 425 deg. the steps were only of 25 deg. The subsequent determinations concerned the Brinell hardness and the grain size of the many specimens obtained. The paper is illustrated by a dozen excellent plates of micrographs, the etchings having been made with the aid of ammonia and hydrogen peroxide. The Brinell hardness numbers increased with increasing reduction by rolling, and decreased on annealing with higher temperatures, after having first risen during the heating up to about 200 deg.; the hardness numbers were about 160 at 0 deg. C. and 170 at 200 deg., and then diminished rapidly near 300 deg. down to 80 at 400 deg. and finally to 40 at 850 deg.; between 600 deg. and 800 deg. all the specimens gave the same curves, and the influence of the amount of rolling was no longer traceable then. The thickness of the sheet as such, apart from the rolling-down, did not affect hardness nor grain size. For the selection of standard materials the specimens should have been rolled down at least 50 per cent. With low-temperature annealing the grain size observed was much influenced by the development of the grain size before annealing. On the whole, hardness measurement seems to offer a better criterion for the value of a brass than grain-size determination.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—General gratification is expressed at the news that the Italian Government has revoked the decree under which it was proposed to establish in Italy a permanent State monopoly with regard to the importation and distribution of coal. The effect of the decision, which is of particular interest to South Wales, will eventually be to restore the pre-war import position in Italy and probably to lead to the abandonment of the control exercised in this country by the Italian Commission over the shipments to Italy. Already the quantity sent to Italy through private exporters under the pooling scheme is increasing. At the present moment tipping facilities are causing exporters anxiety, and it is extremely difficult, even when the coals are at hand, to arrange for the loading of vessels. Even when vessels are under the tips, loading is comparatively slow, as many of the hoists are in need of a thorough overhauling, which was not found possible under war conditions. With the exception of the cheaper descriptions of small steams, there is an all-round good demand for all grades of coal at the scheduled prices. There is no change in the coke position, but it is officially announced that the subsidies will be terminated on April 30 next. Pitwood is in brisk request, and arrivals are quite insufficient to meet the needs of colliery owners, and already some pits are finding it difficult to keep going on account of the scarcity. Some collieries have also been reported to be "on stop" owing to a scarcity of empty wagons.

Newport.—Chief interest has centred this week in the placing of the Egyptian State Railways contract for 150,000 tons of Monmouthshire steam coals over the three months commencing next March. Arrangements for the shipments of the coals have already been placed, and the exporters are on the market for tonnage at the scheduled rate of 47*s.* 6*d.* Alexandria. It is stated that tenderers were asked for American, and Natal as well as Welsh coals, and there is reason to believe that the bulk, if not the whole, of the contract has been placed for Welsh coal. The prices tendered were the scheduled prices of which the shippers will retain 1*s.* commission as well as the 2*d.* fittage.

Earnings of Welsh Miners.—The statistical department of the Monmouthshire and South Wales Coalowners' Association have issued a statement giving interesting data relative to the average earnings of colliers, timbermen and other piece workers in November, 1918, as compared with the pre-war rates. These show that while in 1914, out of a total of 40,311 colliers represented in the returns, 27,474 earned on an average 3*l.* a week or less, in 1918 out of a total of 39,736, only 681 received so low a wage, and less than 4,000 were in receipt of less than 4*l.* a week. In 1918, nearly 26,000 colliers were paid between 4*l.* and 6*l.* a week, 1,427 colliers earned between 8*l.* and 10*l.* a week, and 330 earned over 10*l.* a week. The average wages of all men and boys employed underground in 1918 amounted to over 173*l.*, as compared with 94*l.* in 1914. These figures are of particular interest in view of the miners' demands for an increase of 30 per cent. on the present wage rate.

THE LAWS OF HEAT TRANSFER: ERRATUM.—A numerical slip occurs in our article in our issue of January 31, on the above subject, where, in commenting on page 146, column 2, on the general character of turbulent flow, it is stated that in linear flow "privileged particles" move 50 per cent. faster than the average. Actually they move 300 per cent. faster.

FORGING AND THE DENSITY OF STEEL.—It is generally assumed that forging compresses the steel. There are not many definite data extant, however, and the increase in density produced by forging may not be of importance, except in cases of porous steel. To test this point, Mr. H. E. Doerr, of the Scullin Steel Company, Missouri (Bulletin of the American Institute of Mining Engineers) selected 10 ingots from 1,000 ingots, cast in different heats, but all a 0·53 per cent. carbon, basic open-hearth steel of the same composition. Each ingot was cooled for 30 minutes in the mould, air-cooled for 12 hours, reheated to 2,250 deg. F. after discarding the ingot head, and then forged from a diameter of 3¼ in. down to 1¼ in. under the steam hammer; that operation took 1 minute. Cylindrical specimens, ¼ in. in height and diameter, were afterwards turned from both the forged portion and the unforged portions of the ingot. The 10 pairs of specimens were submitted for examination and analysis to three experts, two being professors, the third the chemist of the company; the experts were not given any information as to the origin of the specimens. The results of their density determinations were not very concordant. The three density determinations of the first pair, *e.g.*, gave the values: Forged 7·807, 7·86, 7·826, and unforged 7·732, 7·81 and 7·781. The fact is pointed out without explanatory comment. Yet all the determinations—except one—show that an increase in the density was produced by the forging, the average values of all the determinations being: Forged 7·821, 7·849, 7·845, and unforged 7·762, 7·798, 7·803, giving the total averages: Forged 7·838 and unforged 7·788. The percentage increases in density of the forged steel of the three observers would be 0·76, 0·65, 0·54, the total average being 0·64 per cent. With ingots of the size used (3¼ in. diameter, 12 in. high) the ratio of volume to superficial area is so great, Doerr points out, that the ingot would hardly solidify without the formation of microscopic cavities; with larger ingots the percentage of increase in density would probably be negligible.

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, February 21, at 7.30 p.m., at 39, Victoria-street, Westminster, S.W. Paper by Mr. J. J. Shaw, Secretary, British Association Seismological Committee (Hon. Member), "Earthquakes and How they are Recorded."

THE ROYAL SOCIETY OF ARTS.—Monday, February 24, at 4.30 p.m., Cantor Lecture: "The Scientific Problems of Electric Wave Telegraphy," by Dr. J. A. Fleming, F.R.S., Professor of Electrical Engineering, University College, London. (Lecture III.) Tuesday, February 25, at 4.30 p.m., Colonial Section: "Key Industries and Imperial Resources," by Mr. Edward J. Duveen, Fellow of the Royal Statistical Society. Mr. W. A. S. Hewins, M.A., late Under-Secretary of State for the Colonies, will preside. Wednesday, February 26, at 4.30 p.m., Ordinary Meeting: "The Wage Problem in Industry," by Mr. William Lionel Hichens (Chairman, Messrs. Cammell Laird and Co.). Mr. W. A. Appleton, C.B.E., Secretary, General Federation of Trade Unions, will preside.

THE ILLUMINATING ENGINEERING SOCIETY.—Tuesday, February 25, at 8 p.m., at the Royal Society of Arts, John-street, Adelphi, when a paper, entitled "Some Notes on Railway Lighting and its Maintenance," will be read by Mr. A. Cunnington (Lighting Engineer to the London and South-Western Railway).

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, February 25, at 6 p.m. Lantern Lecture by Mr. J. H. Anderson (Member) on "The Winning and Preparation of Coal at the Mines."

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 25, at 5.30 p.m. Papers to be submitted for discussion: "The Flow of Water in Pipes and Pressure Tunnels," by Mr. Frederick John Mallett, Assoc.M.Inst.C.E.; "Discharge of Large Cast-Iron Pipe-Lines in Relation to their Age," by Mr. Alfred Atkinson Barnes Assoc.M.Inst.C.E.

THE CONCRETE INSTITUTE.—Thursday, February 27, at 5.30 p.m., at Denison House, 296, Vauxhall Bridge-road, S.W. Paper by Mr. E. Willis, Assoc.M.Inst.C.E., on "Industrial Safety First."

THE BIRMINGHAM METALLURGICAL SOCIETY.—Thursday, February 27, at 7 p.m., at the Birmingham Chamber of Commerce, New-street. Paper by Professor C. A. Edwards, D.Sc., The University, Manchester, "Methods of making Hardness Determinations, and the Significance of the Data Obtained."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 27, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Paper on "The Determination of the Efficiency of the Turbo-alternator," by Dr. S. F. Barclay and Dr. S. P. Smith.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, February 28, at 5.30 p.m., a discourse will be delivered by Sir Oliver Lodge, Kt., D.Sc., F.R.S. The subject will be "Ether and Matter." Afternoon Lectures at 3 p.m.: Tuesday, February 25, Captain G. P. Thomson on "The Dynamics of Flying" (Lecture II); Thursday, February 27, Professor H. Maxwell Lefroy, M.A., F.E.S., F.Z.S., on "How Silk is Grown and Made" (Lecture II); Saturday, March 1, The Hon. J. W. Fortescue, C.V.O., LL.D., on "The Empire's Share in England's Wars—Eastern Empire" (Lecture II).

THE JUNIOR INSTITUTION OF ENGINEERS (MIDLAND SECTION).—Friday, February 28, at 8 p.m., in the University of Birmingham, when Mr. T. Lewis, M.A., B.Sc., will give a paper on "The Boys' Welfare Movement."

THE CIVIL ENGINEERS' APPOINTMENTS BOARD.—This Board, which was established in 1912, is doing good work in aiding engineers who have been serving in the Army or Navy in securing appointments on their return to civil life. The Board includes among those registered with it a considerable number of fully trained engineers who have resigned or who are about to resign their commissions in the Army, and invites inquiries from employers in all branches of engineering who want assistants. Notice of vacancies for pupils or apprentices will also be gladly received from members of the Institution of Civil Engineers. Communications (by letters only) should be addressed to the Manager of the Board, at 8, Princes-street, Westminster, S.W. 1.

THE ENGLISH ELECTRIC COMPANY, LIMITED.—We are informed that the English Electric Company, Limited, has now gone to allotment. It will be remembered that this company, having arranged to acquire the whole holding of preference and ordinary shares in the Coventry Ordnance Works, Limited, and the Phœnix Dynamo Manufacturing Company, Limited, made an offer to Messrs. Dick, Kerr's shareholders to exchange shares on certain terms. It is now announced that about 90 per cent. of the Messrs. Dick, Kerr's shareholders have accepted the offer. The English Electric Company, Limited, will control directly or through Messrs. Dick, Kerr and Co., Limited, the following powerful group of manufacturing interests, viz., the Coventry Ordnance Works, Limited; Dick, Kerr and Co., Limited; Phœnix Dynamo Manufacturing Company, Limited; the United Electric Car Company, Limited, and Willans and Robinson, Limited. The company is registered with a capital of £5,000,000 in 1,500,000 £1 preference and 3,500,000 £1 ordinary shares, and the issued capital on allotment is just under 2,000,000*l.*

HORIZONTAL DUPLEX BORING, DRILLING AND TAPPING MACHINE.

CONSTRUCTED BY MESSRS. G. AND A. HARVEY, LIMITED, ENGINEERS, GOVAN.

(*For Description, see Page* 241.)

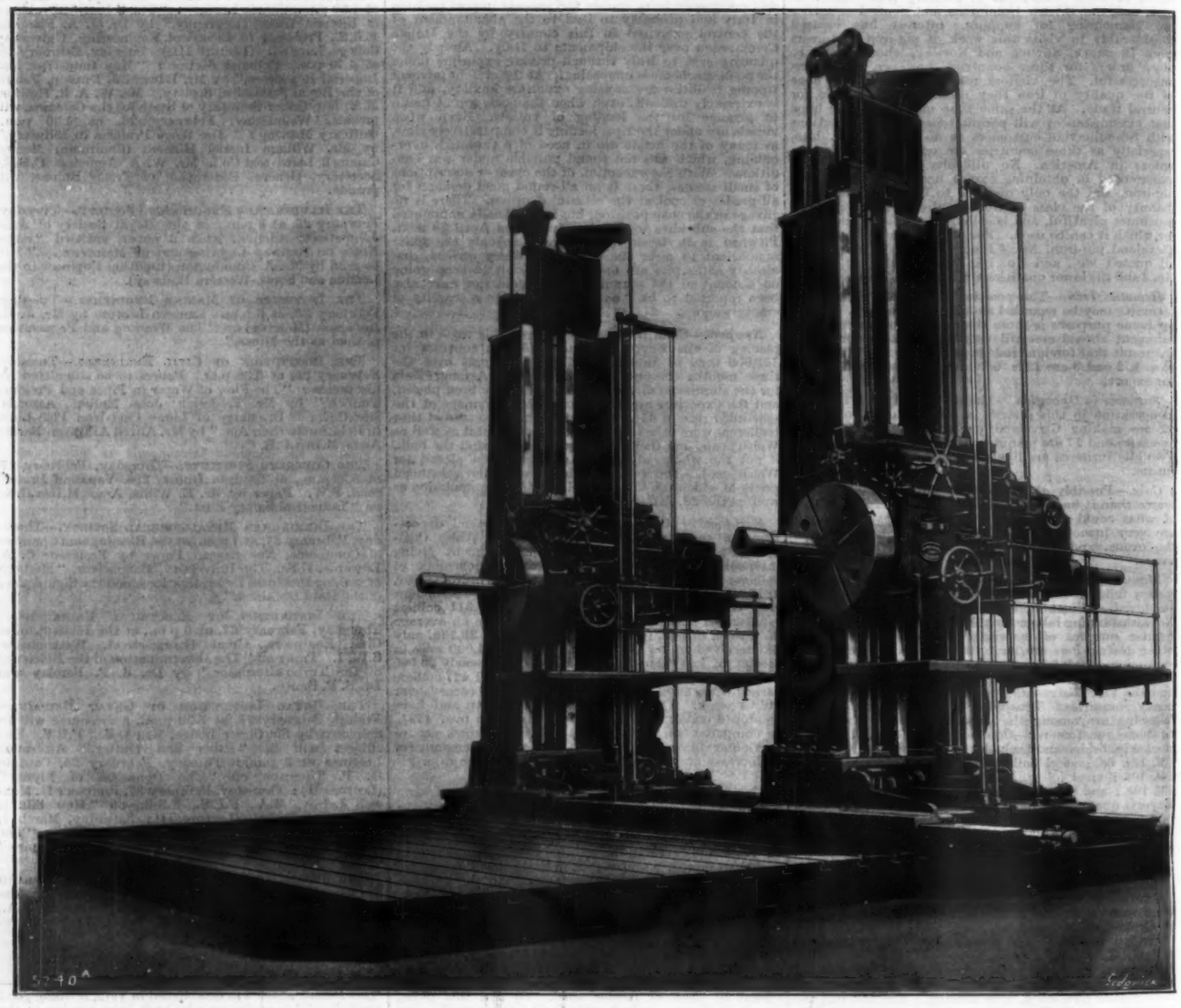


Fig. 4.

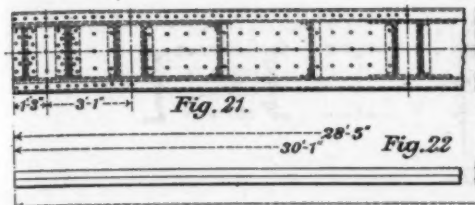
Castor Oil for Aircraft Engines.—The demand for castor oil as a lubricant for aircraft engines has assumed enormous dimensions during the war. Before that time India was the chief source of supply of the material, both the seed and the oil being exported. From the Journal of the Society of Chemical Industry, January 3, we see that India exported in castor beans 120,194 tons in the year ended March, 1912, and 134,888 tons in 1914; the following year the exports went down to 82,815 tons and, keeping pretty steady later, they amounted to 86,100 tons in 1917–18. The castor oil exports of the same years were, in gallons: 1,404,443, 1,007,001, 898,269, 2,086,038. Thus the oil exports kept on increasing; most of the oil went, before the war, to Australia, and during the war to the United Kingdom, at Hull or Liverpool. This country had other sources of castor oil supply as well; of castor seeds, 45,000 tons were imported in 1917, and assuming this bulk to yield 40 per cent., i.e., 18,000 tons of oil at 232 gallons, equal to 4,176,000 gallons of oil, the country imported over 6,000,000 gallons of castor oil in 1917, most of which probably served as lubricant for aircraft. Many other countries have meanwhile taken up or developed the cultivation of castor oil plants. The United States secured 7,000 tons of seeds from India, and started plantations in the Southern and Pacific States; very large seed-crushing mills have been opened at Gainesville, in Florida, and at Jacksonville, in the same State, four types of American oil-seed crushers were recently tested. Further to secure the supply of lubricants, the United States Signal Corps experimented with petroleum, and evolved the "Liberty Aero Oil," which is to be used chiefly for stationary-cylinder aircraft machinery, whilst the castor oil is to lubricate rotary engines. The castor oil has to satisfy the specifications: Colourless; density, 0·959 to 0·968 at 60 deg. F.; completely soluble in four volumes of alcohol; maximum acidity not to exceed the equivalent of 1·5 per cent. of oleic acid; iodine number 80 to 90, saponification number 176 to 187; unsaponifiable, below 1 per cent.; free of rosin, rosin oil or cotton-seed oil; flash-point, 450 deg. F. in an open Cleveland cup; freezing point below zero F; viscosity (Saybolt), 450 seconds at 130 deg. F. or 95 seconds at 212 deg. F. Extensions of the castor oil industry are reported from Brazil, Venezuela, China, Cochin China, Manchuria, Japan, Java, New South Wales, East Africa, the Congo, French West Africa, recently also from the Transvaal and from Italy.

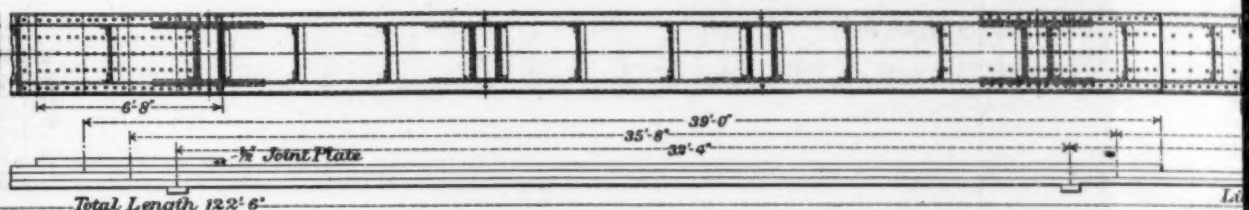
Coal and Rolling-Stock Difficulties in Germany.—The German industry is beset by a number of serious difficulties, and grave apprehensions are expressed by its leaders as to its future. During the last peace year (1913) the production of coal in the Ruhr district averaged 9,540,000 tons per month. During the first three-quarters of last year it averaged 8,380,000 tons per month, during the month of October it was 8,450,000 tons, in November it fell to 6,250,000 tons, and in December to 5,770,000 tons, or about the same as August, 1914, when some 30 per cent. of the men were called to the front. This very unsatisfactory result, according to a report by the Union of Mining Concerns in Essen, is due principally to the continuous labour unrest in the district; during November there was hardly a day without work being stopped at one or several mines, and during December the stoppage of work was further enhanced, owing principally to the efforts of the Spartacus people. The number of lost shifts in November amounted to about 800,000. The loss to the industry of 60,000 prisoners of war also accounts for decrease in output. The shortage of rolling-stock becomes more and more pronounced and detrimental to industry generally. During the war the number of 10-ton wagons available per day in the Ruhr district was 23,600, on November, 17 it had fallen to 14,700, and on January 11 to 8,500. In times of peace (1913) the number of wagons available per day amounted to 32,000, or about four times as many as now. In Upper Silesia the labour troubles have caused relatively still greater havoc, the daily production having receded from 14,000 wagon loads in peace times and 11,000 during the war, to some 2,000. All consumers of coal are suffering, gas and electricity companies are run, so to speak, from hand to mouth, and a number of industrial concerns have had to stop or to go on working at a much reduced rate. The State works at Spandau, which employ some 50,000 men, have had to close for want of coal. The railway traffic is in a very precarious state from the insufficiency and the miserable state of the rolling-stock; it has already been curtailed wherever possible, and it is believed, will have to be still further cut down. The locomotives cause special trouble and the repair shops are working in a most dilatory manner.

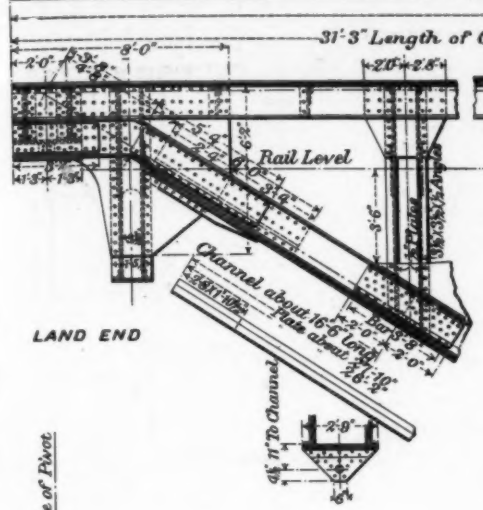
THE SOUTHAMPTON TRAIN FERRY; DETAI

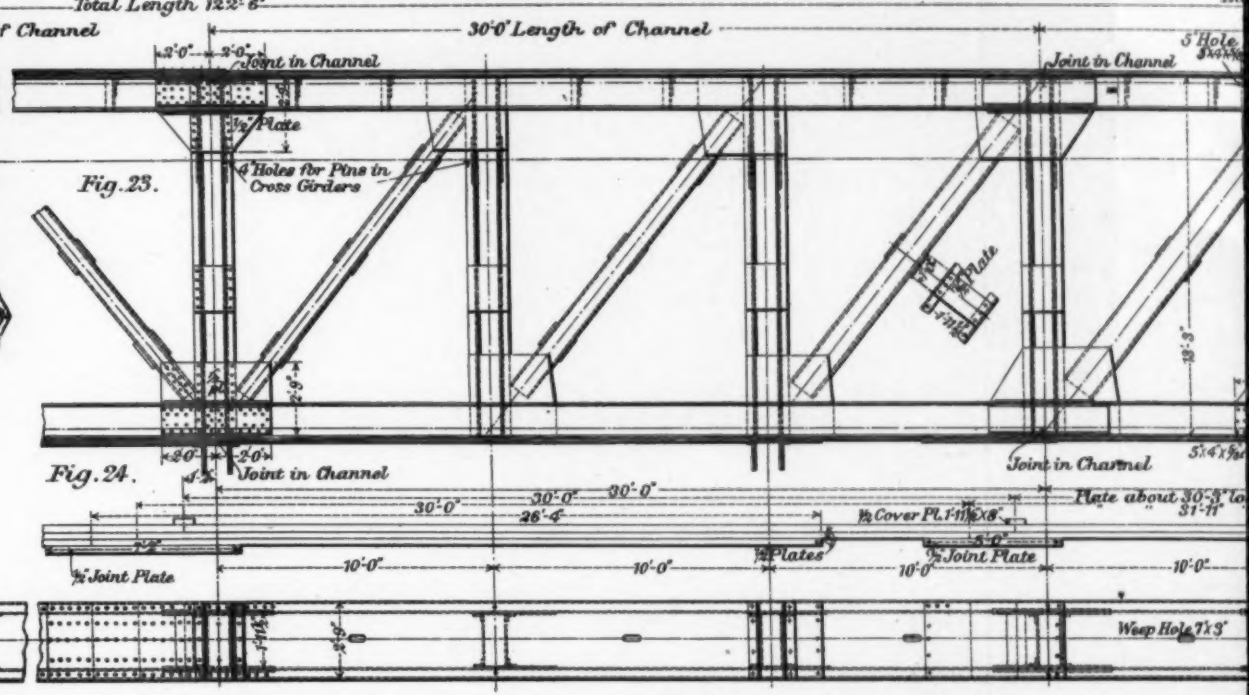
CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LI

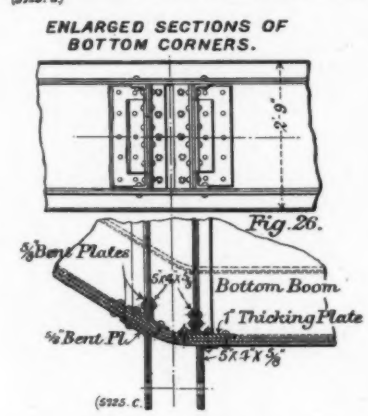
(For Description, see Page 238.)

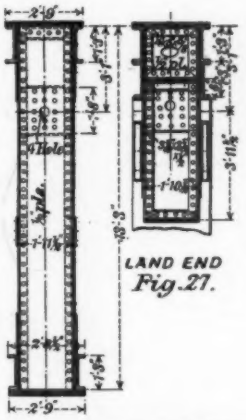


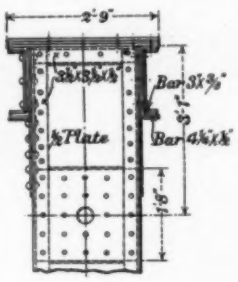


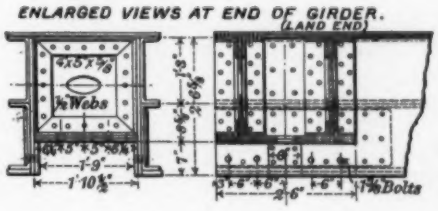


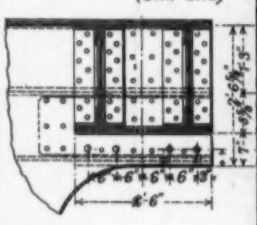


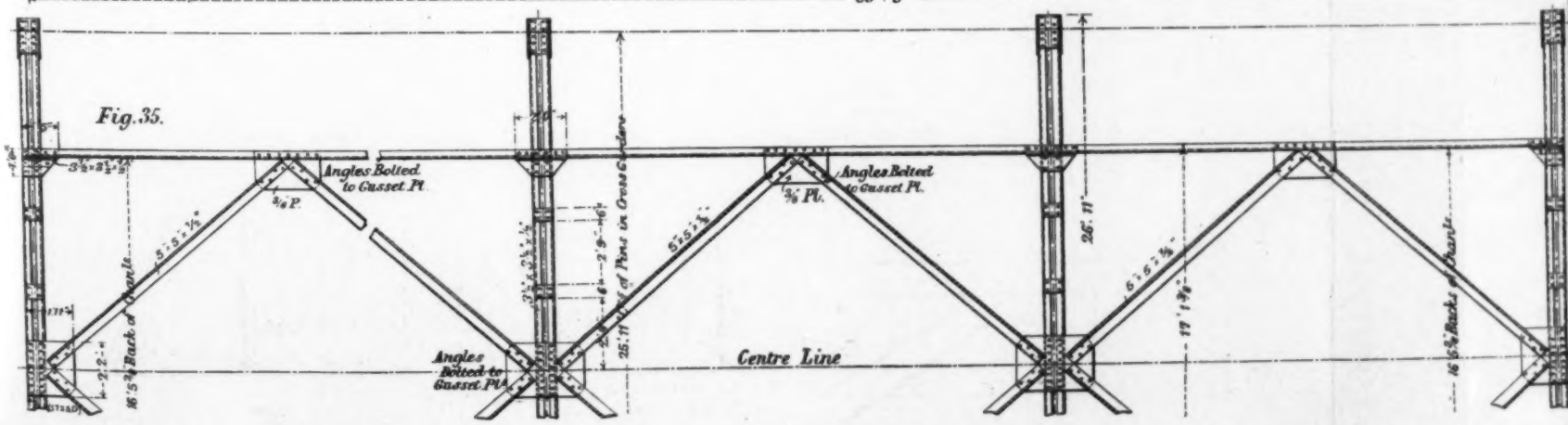












SOUTHAMPTON TRAIN FERRY; DETAILS OF

CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, ENGINEE

(*For Description, see Page* 238.)

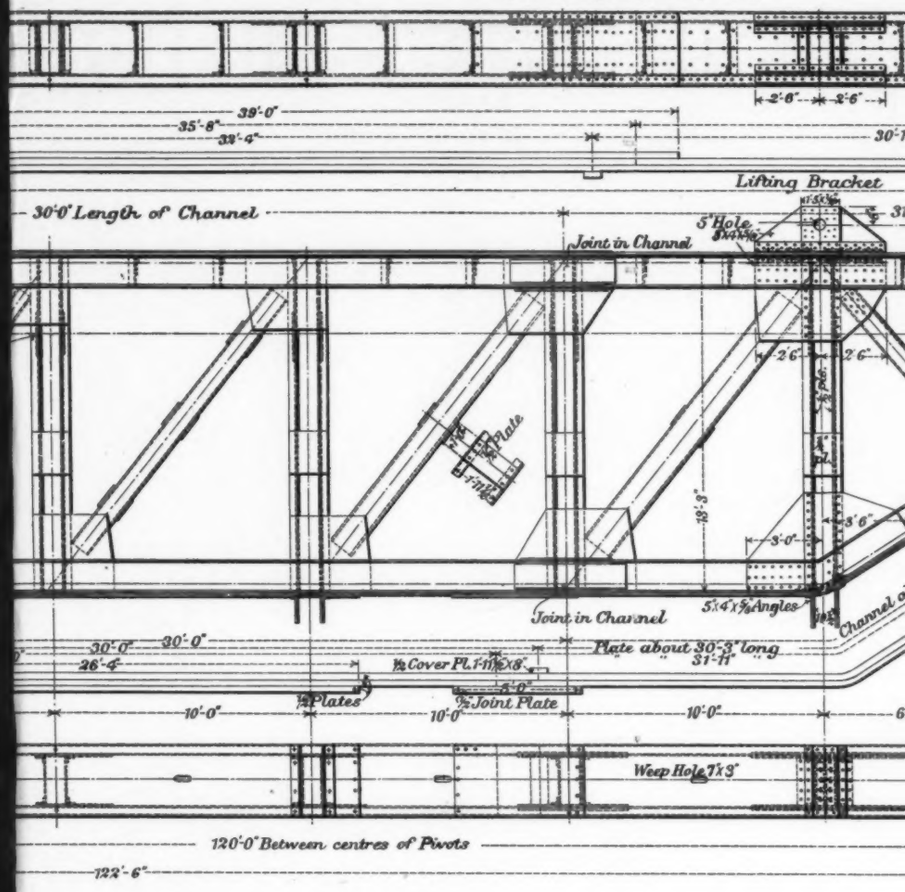


Fig. 28.

ENLARGED VIEWS AT END OF GIRDER.

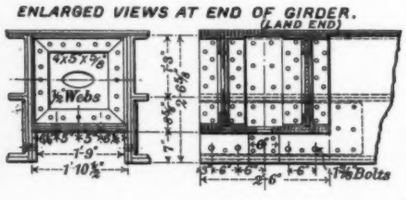
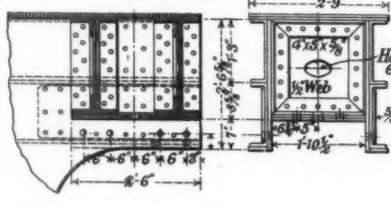


Fig. 29.

ENLARGED VIEWS AT END OF GIRDER.



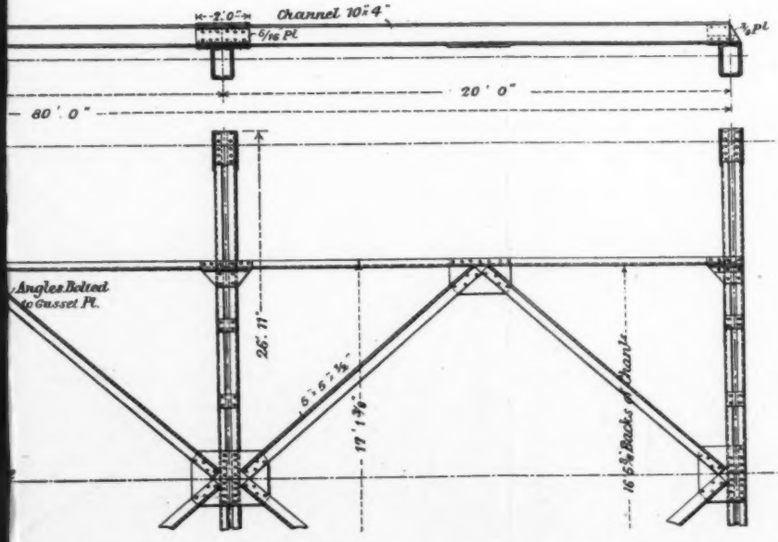
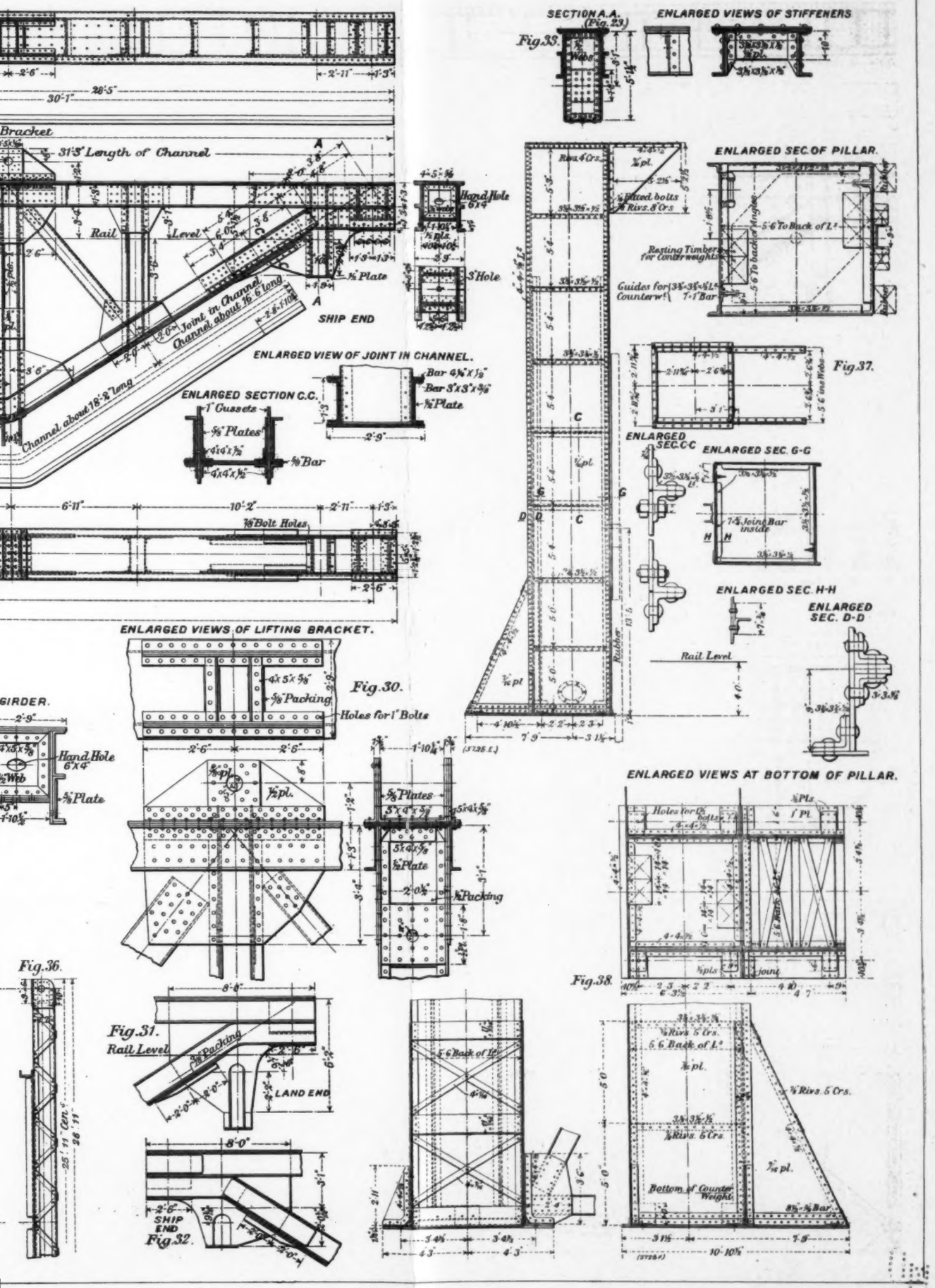


Fig. 36.

OF TRAIN FERRY BRIDGE.

, ENGINEERS, NEWCASTLE-ON-TYNE.

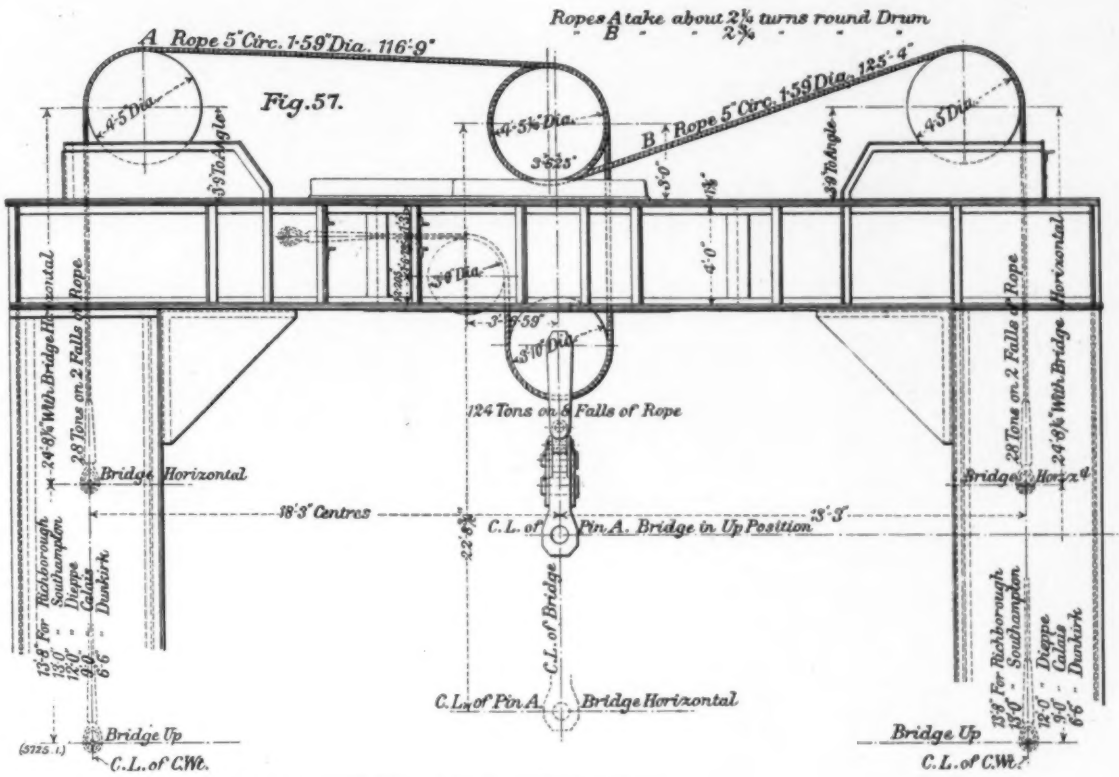


THE SOUTHAMPTON TRAIN FERRY; DETAI

CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIM

(*For Description, see Page* 238.)

Fig. 57.



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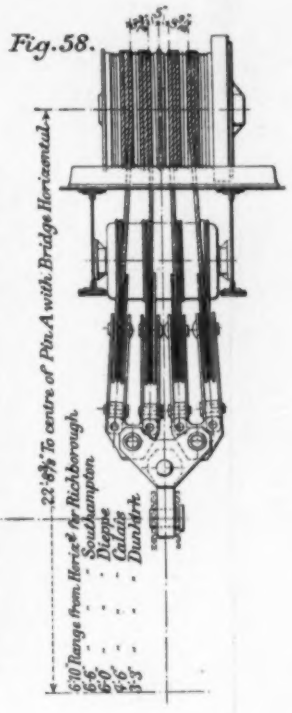

22'-8½" To centre of Pin A with Bridge Horizontal
6'-0" Range from Horiz.l for Richborough
5'-6" " " Southampton
6'-0" " " Dieppe
4'-6" " " Calais
3'-5" " " Dunkirk

Fig. 59.

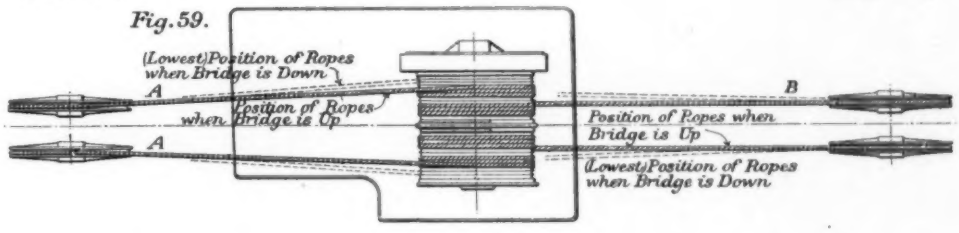

(Lowest) Position of Ropes when Bridge is Down
A
Position of Ropes when Bridge is Up
B
Position of Ropes when Bridge is Up
(Lowest) Position of Ropes when Bridge is Down

Fig. 60.

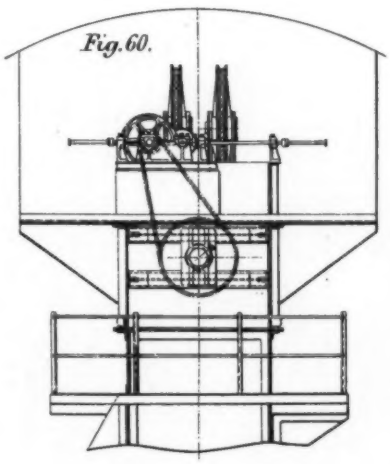
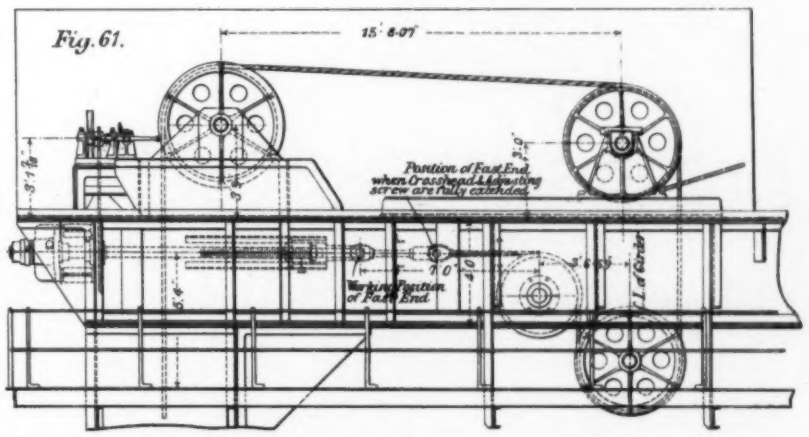


Fig. 61.



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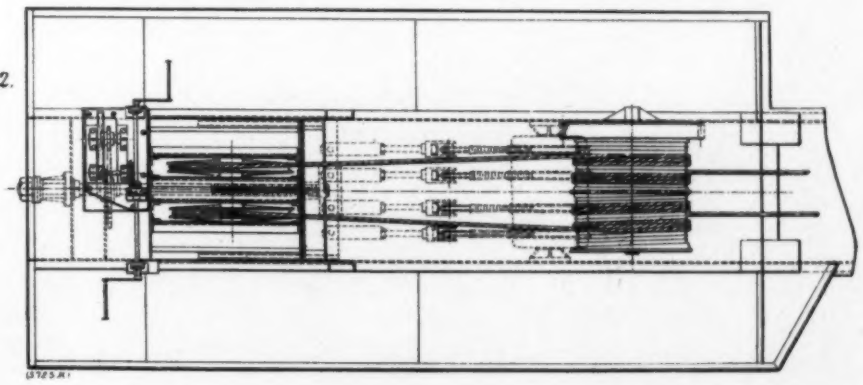
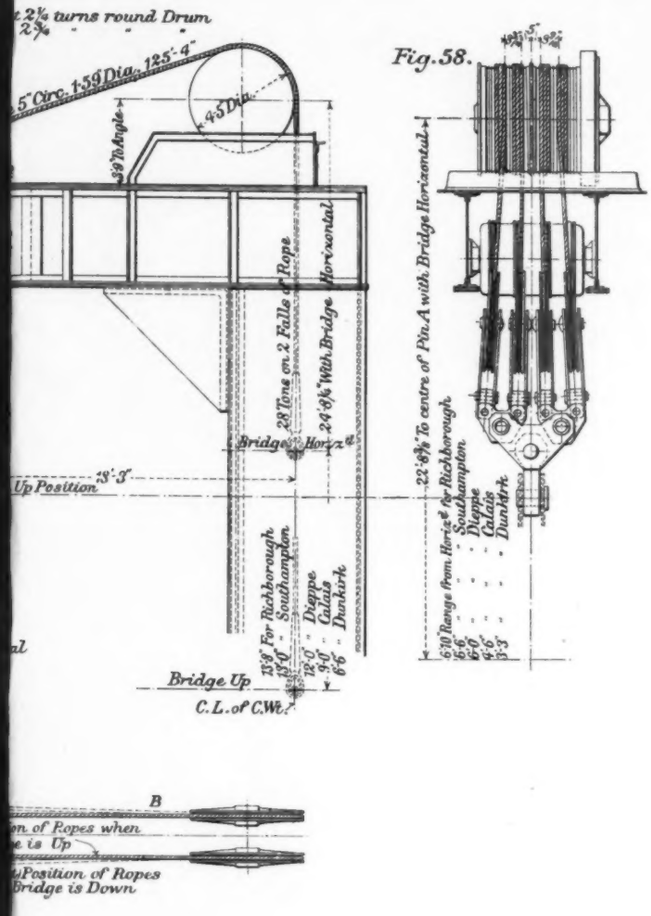


HE SOUTHAMPTON TRAIN FERRY; DETAILS

CONSTRUCTED BY SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED,

(*For Description, see Page* 238.)



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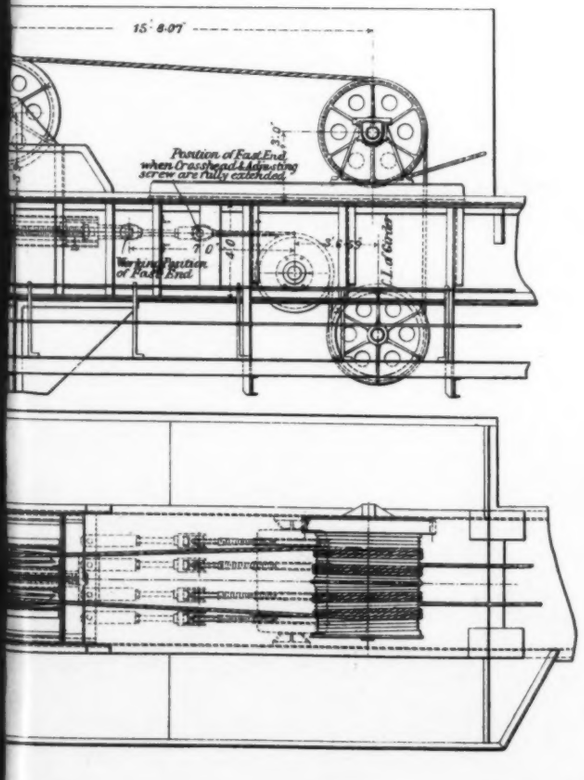

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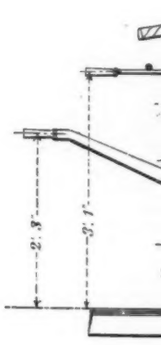

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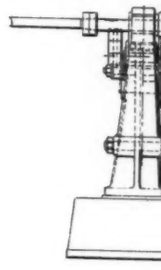

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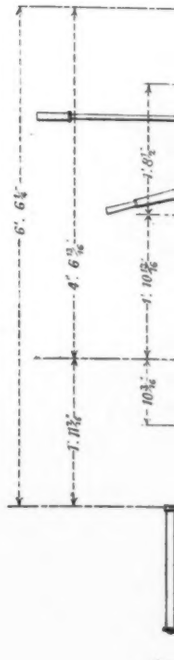

ILS OF TRAIN FERRY BRIDGE.

IMITED, ENGINEERS, NEWCASTLE-ON-TYNE.

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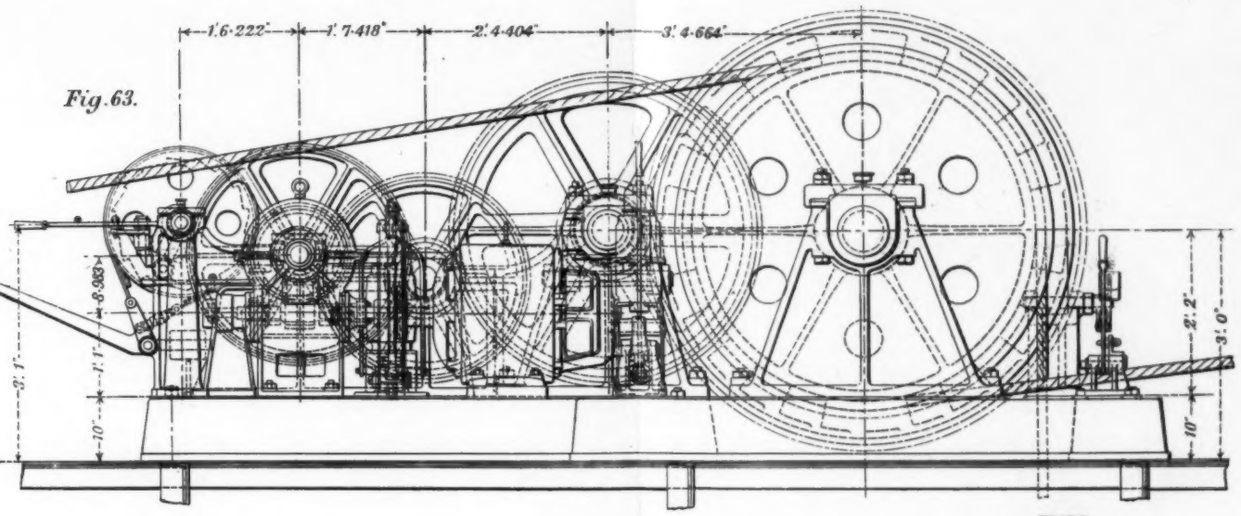
Fig. 63.



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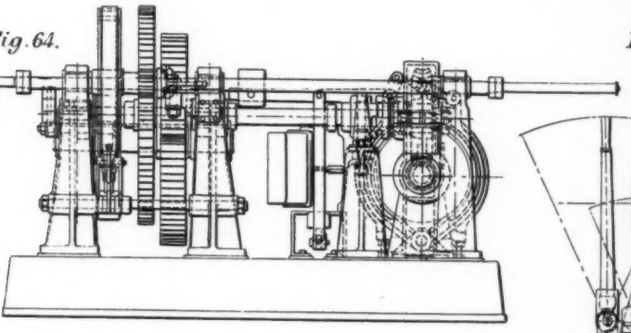

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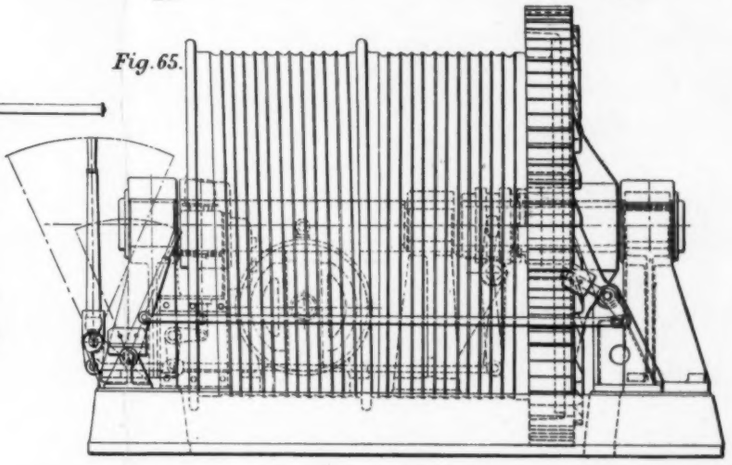
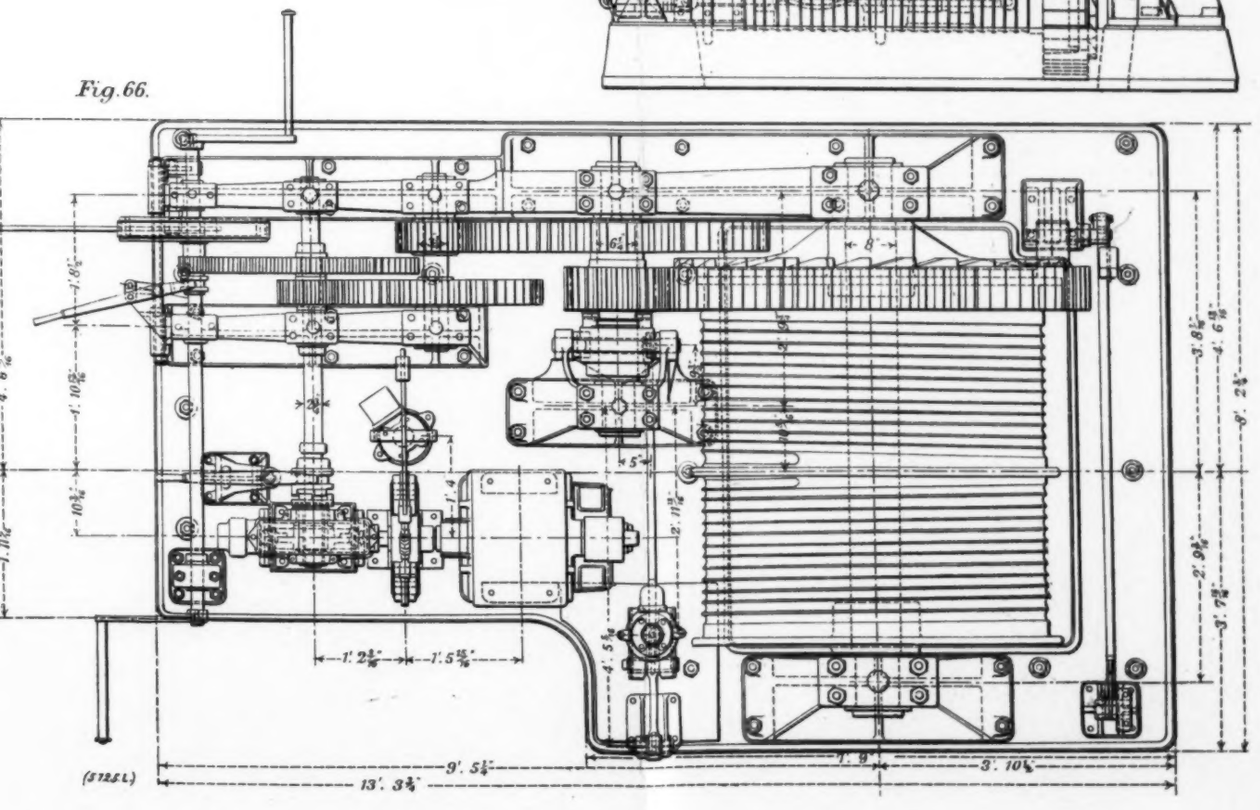


Fig. 66.



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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than Monday morning.

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TELEPHONE NUMBERS—3663 and 8598 GERRARD.

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NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of Supplies, Newsagents will not have copies for chance customers: therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 243

ENGINEERING.

FRIDAY, FEBRUARY 21, 1919.

THE CASE FOR THE CONCRETE ROAD.

THE necessity for improved methods in road construction to meet the demands of modern traffic conditions is so evident, and has found such frequent expression in the technical and general press during recent months, that any elaboration of the theme is here superfluous, and the need may presumably be taken for granted. The question now is how to meet this new demand; what form of construction is best calculated to satisfy the conditions which such a demand imposes—in other words, what is the ideal road? Before considering this problem, which undoubtedly has to be faced without delay, the mind should be cleared of all bias and the matter regarded calmly and dispassionately in the light of recent experience. True, experience of modern traffic conditions which have, of late, developed with phenomenal rapidity, has been but brief, yet brief as it may be it is sufficient to form a clear indication of our future needs and to serve as a guide for future methods; and at the present time, when so many of our highways call for renewal, if not for complete reconstruction, a convenient opportunity is provided for considering this matter.

To come to essentials. What are the requirements of a good road?—(1). It must be hard, firm, and have a long life. (2). Its surface must offer a low resistance to wheel traffic. (3). It should be dustless and easy to clean. (4). The surface should be even without being slippery. (5). It should not be affected by climatic conditions. (6). The first cost must be reasonable and the maintenance should be low.

It goes without saying that the road which most fully satisfies these conditions approaches most nearly to the ideal road, and, even making allowance for what may be regarded as the exaggeration of the concrete enthusiast, it is surprising that, with our present knowledge, the concrete road has not received greater consideration in this country, since this form of construction, when its claims are examined, would appear to be such as to meet to a large extent all the demands made upon it.

To consider the requisites in turn.

Of the hardness of well-made concrete there can, of course, be no question, but the length of life depends upon various other considerations.

The second requisite is that the road should offer a low resistance to the movement of the traffic over it. This is important, because in the construction of a road, regard should be had, not only to the effect of the traffic upon the road, but also to the effect of the road upon the traffic, that is to say upon the vehicles which use it. If the tractive effort is great the cost to the user in energy is high, with a consequent loss to the community. Thus, under the new conditions, roads over which travelling is difficult will result in the loss of large sums of money annually from this cause alone. Some little time ago a series of experiments were carried out in California under uniform test conditions, with a view to ascertaining the amount of pull necessary on different road surfaces to keep 3 tons of load in motion after it had been started. In the result it was found that on water-bound macadam in good condition the pull was 64 lb. per ton, on a bituminous road 49 lb., and on unsurfaced concrete 28 lb.; in other words, the load that would be kept in motion by four horses on an unsurfaced concrete road would require seven on an asphaltic surface, and nine on a water-bound macadam.

The concrete road being monolithic, and composed of a material of great density and hardness, it does not disintegrate under the traffic, and does not soften with rain or snow. No dust is therefore caused, and consequently no mud, which is often a source of danger as well as inconvenience. On the contrary, any foreign matter which may have been blown on to the highway is washed off by the first downpour of rain, and the surface, which soon dries, is clean again. For a similar reason the cleansing of a road, if in a town, may be carried out very easily and rapidly, since it can be washed with water from the hydrants, or can be thoroughly cleaned by any convenient method without wearing away or damaging the surface in any way whatever.

Then the road must be even without being slippery. Most roads are even when they are first made, but the ideal road should remain even and not work into waves or develop holes, since every wave and every hole encountered by a vehicle using the road, causes a jar and a strain which tries the mechanism and eventually results in loss of time and money due to repairs. The surface of the properly-made concrete road has neither of these defects; it does not work into waves nor does it disintegrate or develop holes, and thus vehicles can travel along the road at the utmost allowable speed without fear of shock or stress, or other detriment to their efficiency.

The ideal road should not be slippery. Slipperiness leads to accidents and to loss of energy. The modern concrete road, finished as it is with wooden float or with roller and canvas belt, possesses a surface which affords a good grip for hoof or tyre; and, further, the readiness with which the water runs off the surface, owing to the non-absorbent nature of the material, allows of a considerably less camber than is the case with most other forms of road, and so eliminates the danger of side-slipping when vehicles use the side of the road in order to pass one another. The flatter the road, too, the less temptation is there for drivers to use the middle only, and thus the traffic is equalised, each part of the road bearing its share.

The concrete road is not affected by climatic conditions. In the United States and Canada concrete roads successfully withstand a range of temperature far greater than anything experienced in this country. Frost has no effect whatever upon a concrete road, and provision can be made by means of joints for any possible expansion due to heat. Some of our road engineers hold that where the concrete is sufficiently reinforced no expansion joints are necessary, and certain roads which have stood up under the traffic exceedingly well have been laid on that assumption; but it is the usual practice to provide expansion joints as a precautionary measure.

The most common objection to the concrete road is its initial cost which is acknowledged to be higher than that of macadam, either water-bound or bituminous. The initial cost, however, is not the criterion of economy. This can only be justly estimated by taking into consideration the original outlay, together with maintenance charges over a period of years, and here concrete scores, as has been proved over and over again in the United States, whose experience of concrete roads is much more extensive than our own. In New York State the average initial cost of the three principal types of roadway during 1915 was as follows: Water-bound macadam, 2,050*l.* per mile; bituminous macadam, 2,594*l.* per mile; and concrete, 3,064*l.* per mile. During the year the average maintenance cost of the macadam roads was 210*l.* per mile, and that of the concrete roads 26*l.* per mile, the greater part of the latter, we are told, having been spent on shoulders and ditches and not the roadway itself. In Wayne County, whose eleven years experience of concrete roads has led to the adoption of newer and more careful methods of construction, the cost of maintenance, over 150 miles was, in 1916, 6*l.* 12*s.* per mile. Chester, in our own country, possesses a road which has been laid for seven years, and during this period the cost of maintenance has been 2*d.* per superficial yard per annum, the maintenance consisting of tar-spraying once a year. In the early months of 1915 an experimental stretch of concrete was laid on the London to Chatham road, and for that portion of it which was constructed on approved

modern methods, and which is unsurfaced, the cost of maintenance during the four years has been *nil*.

Many valuable lessons have been learned from the mistakes made when concrete road-making was in the experimental stage, and from the experience thus acquired the following appear to be the chief factors of success and length of life in construction.

Throughout the whole of the operations there must be intelligent and constant supervision in order that no single portion of the work may be neglected or indifferently performed, either through ignorance or carelessness. The foundation must be thoroughly prepared and provision made for proper drainage. Many of the defects which developed in early concrete roads were due to an insufficient appreciation of this important factor.

A careful selection of materials is of great importance. In order to obtain the best results the cement must be of high quality, the coarse aggregate must be clean, hard and graded, and the sand clean and graded from coarse to fine. The proportioning needs careful attention. A reliable specification should be adopted and adhered to throughout the stretch, otherwise there may be differences of contraction and expansion producing internal stresses tending to disintegration. Too little cement means weakness, too much is waste. In order to secure density with economy the materials employed should be so proportioned that all the voids are filled. The mixing should be thorough and the quantity of water employed should be moderate and accurately measured. Modern research has demonstrated that strength is reduced by the use of too great a quantity of water.

Concrete roads should be reinforced, not only to provide against tensile stresses, but also to reduce to a minimum the possibilities of defects due to expansion and contraction. The work in each section or slab of roadway should be continuous. The line of junction between freshly mixed material and that which has already set will be a line of weakness. The concrete should be well consolidated. In modern practice a hand roller is run over the surface immediately the top layer has been placed in position and shaped. This presses out superfluous water and rolls down uneven places. It is claimed that by this method the slabs develop greater strength.

There are two methods of finishing, in one a wooden float is used, and in the other a canvas belt is drawn backwards and forwards over the surface. The latter method is generally adopted when the roller is employed, but either method gives excellent results. The traffic must be kept off the road for at least three weeks, or preferably a month; this, no doubt, is often difficult, but where it is impossible to divert altogether the traffic, it is the practice to concrete half the width of the road at a time.

Some writers on this subject have expressed the fear that access to gas and water mains and electric cables would be very difficult and expensive, and would be disastrous to the road. Experience has proved that these fears are groundless. As has been many times pointed out, it is no more difficult to cut through a concrete road than, say, any other kind of road having a concrete foundation, and if proper care be taken in the cutting and refilling, the road will be as strong, and the surface as good, after the operation as they were in the first instance.

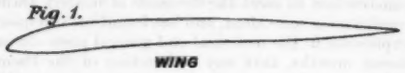
The increasing weight and frequency of the traffic which the roads of this country will, in the future, have to bear, demand that in the national interest the best possible form of construction should be adopted. The strength, durability, and traffic-resisting qualities of the concrete road have been abundantly demonstrated, and the results so far achieved in this method point to the probability, if not certainty, that this form of construction is the one which will be found most nearly to approach the ideal.

THE DEVELOPMENT OF AEROPLANES IN THE GREAT WAR.

At the Royal Institution, on Tuesday afternoon last, Captain G. P. Thomson, gave a lecture on "The Development of Aeroplanes During the Great War."

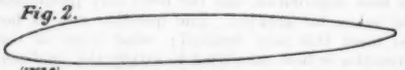
In commencing his address the lecturer said that the fundamental principle of the aeroplane was both old and simple, having been discovered by the primitive savages of Australia and embodied by them in the boomerang, which by meeting in its flight the air at a slight angle got a "lift." Due to this lift its trajectory might be in part horizontal, or it might even rise. Any surface more or less flat which travelled at a slight angle through the air tended to lift. This lift was increased if the section showed a slight camber, and still better results were attained if we used not a thin sheet but a body of appreciable thickness. This the Australians had discovered, and as would be seen from Figs. 1 and 2 there was no great difference between the wing section of a modern aeroplane and a cross-section through a boomerang. The resemblance of the latter was still closer to a propeller section, and, in fact, a boomerang was a sort of cross between an aeroplane wing and a propeller, the two legs of it having a slight twist.

Fig. 1.



WING

Fig. 2.



(SWEAR)

BOOMERANG

As an example of a modern aeroplane the lecturer showed a complete model of a type D.H.10A machine constructed by the Aircraft Manufacturing Company. This machine was, he said, a high-power bomber, which was coming into use just when the armistice was signed. It was a biplane, of which both upper and lower wings had the same chord and span. There were two engines, and the weights of these, of the passengers and of the bombs was concentrated in a small a volume as possible. The craft in flight, therefore, resembled a light boat carrying a very heavy load near its middle. This load was transferred to the wings by trusses built up of struts and ties on the same lines as a bridge truss. The ties were of wire, and were usually duplicated, so that if one was cut the structure would not collapse. This duplication was effected in various ways. In addition, cross-bracing was provided between the back and front struts so that if a front tie were broken the force previously carried by the tie was now taken by this cross-bracing and by a somewhat roundabout path ultimately arrived at the fuselage just as before. The struts were not duplicated, and a machine was not guaranteed to fly if one were carried away. As a matter of fact, however, flight was still possible, as the speaker could testify from personal experience. A machine on which he was acting as observer broke a strut by colliding with a tree. Nevertheless they got safely home. At the time he had made a rapid mental calculation which led him to believe that the margin of safety was still considerable. This was reassuring, but subsequent consideration showed that in the excitement of the moment he had omitted to include certain factors, and the margin was, it turned out, really much smaller than he had believed at the time.

In the earliest machines the struts were round bars or tubes, but it was soon found that the head resistance could be greatly reduced by "fairing" the sections, giving them a rounded nose and a "fined" tail. The consequent reduction in the resistance was surprising. With a round section moving at 100 ft. a second, the resistance per square foot of area (taken normally to the line of flight) amounted to 12 lb. or 13 lb. per square foot. By adding to this section a rounded nose and a fined tail its resistance was reduced to only 1 lb. per square foot, and for the same normal area the strut had, moreover, a greatly increased cross-section. A machine might easily have a dozen struts 7 ft. or 8 ft. long, so the reduction in the total head resistance due to fairing these was very considerable. The effect of the fairing was due to the fact that if moving air met with an obstruction not too sharply curved it would bend round it very completely, and the conditions then approximated fairly closely to those which were assumed in the mathematical theory of perfect fluids. With these, however, the obstruction would offer no resistance whatever. If, however, the curvature of the obstruction encountered by the air was too sharp the fluid no longer followed the contour, but broke away from it, leaving a space behind the object, which became filled with a turbulent mass of fluid, and the resistance then became very large.

Shaped wires were also used for aeroplane ties. These, however, were symmetrical sections similarly pointed fore and aft, and their resistance was correspondingly higher, being about 4½ lb. per square foot of projected surface when exposed to an air current moving at 100 miles per hour. Even this result, however, was a great improvement on the figure corresponding to round ties, particularly when allowance was made for the fact that a greater cross-section was obtained for the same normal area exposed to the wind.

The D.H. 10A machine had, the lecturer proceeded, two 400-h.p. Liberty engines which had proved very satisfactory. Its maximum speed at a height of 10,000 ft., when moving on the level, was 123 m.p.h.

An aeroplane, the lecturer proceeded, had three sets of control surfaces, viz., the rudder, the elevator and the flaps or ailerons. The elevator was merely a horizontal rudder which turned the nose of the machine up or down, but the action of ailerons or flaps as they were called in this country, was more complicated. These flaps formed part of the trailing edges of the wings; and provision was made so that these flaps could be moved down so as to increase the camber of the wing, or pushed up so as to flatten it. The controls were interconnected so that as one wing was more cambered the opposite wing was flattened. The lift of the one wing was thus increased and of the other diminished. The result of this was to roll the machine. The flaps and the elevator were controlled by a single lever, known as the "joy stick." Pushing this forwards or back actuated the elevator, whilst a transverse motion actuated the flaps. The use of these flaps was now universal. The Wrights had used a different arrangement, one wing being twisted up, whilst the other was twisted down. The control thus secured was enormous, but the machine was a very uncomfortable one. In "bumps" the control stick was struck backwards and forwards, and tales were told of the hands of pilots being rendered bruised and bleeding by the jerks of this joy stick.

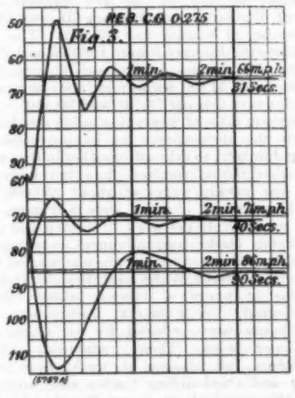
The lift of a wing increased as the square of the speed, and directly as the angle of incidence up to a limit of about 16 deg. Any machine, however loaded, would fly if sufficient speed were attained. This minimum speed at which the machine would just fly was known as the "stalling" speed.

For the D.H. 10A. machine this was about 40 miles to 50 miles an hour. It depended on the weight per square foot of the wing surface and also on the form of the wing. In modern machines the stalling speed was higher than in the early machines, since although we now got 1 h.p. for 2 lb. of weight instead of 5 lb. or 6 lb. as formerly, the total horse-power fitted was five or six times as much as seven years ago, and the total weights had thus gone up. This increase in the stalling speed rendered necessary great skill on the part of the pilot when landing. The "stalling" of a machine near the ground was a very serious matter. The pilot of a modern machine had therefore to approach the ground at a speed reasonably above that of stalling, say at 70 miles an hour. When he had got within 10 ft. or 15 ft. of the ground he pulled the elevator and flattened out. The engine being shut off, the machine continued to fall and the pilot then "held off" the ground as long as he could, skimming it with a few inches. Finally the stalling speed was reached and the machine gently settled down through these few inches. At least this was the ideal way of landing. How nearly it was realised depended on the skill of the pilot.

The upper limit to the speed of an aeroplane depended on the power available. In level flight this was provided wholly by the engine. Although air resistance at flight velocities varied as the square of the speed, the propeller thrust did not, as might perhaps be anticipated, vary as fast as the square of the speed, but at some power between the first and second and the horse-power varied correspondingly at some power of the speed between the square and the cube. This was due to the fact

that at high speeds the angle of incidence necessary for level flight was reduced, and with it the head resistance. If the flight path were not level, gravity had a component along the line of flight, which added to the effective thrust if the machine were descending, and was substracted from it when the machine was going up. With modern machines the gliding angle was about 1 in 6. and the velocity during the glide about 70 miles an hour. With a gliding angle of 1 in 6 a machine, if its engines stopped, could, if flying at a height of over 5,000 ft., nevertheless reach any point of the ground within a circle of about 12 miles diameter—the area available for alighting was thus about 40 sq. miles.

In climbing there was a definite angle giving the quickest climb. This would be readily seen from the analogy of a motor car required to climb to a height of 1,000 ft. and having a choice of gradients. If the latter were very flat the car would have to travel over a very long distance to reach the required elevation, whilst on a very steep gradient its speed would be low or zero. With modern aeroplanes the best climbing speed was rather below that of a comfortable glide, being about 60 m.p.h. to 70 m.p.h. The demand for climbing power had greatly increased during the war. The standard limit of height was first 3,500 ft. This was then raised to 6,000 ft. and later to 10,000 ft., whilst to-day makers were required to specify the time required to climb to 15,000 ft. or 20,000 ft. The



actual limit of height to which a machine could attain was known as the ceiling, and was at present about 30,000 ft. In reading newspaper statements about climbs it should be noted whether the heights recorded were aneroid readings or not, since makers of aneroids assumed in graduating their instruments that these would be used at a constant temperature of 10 deg. C. At great heights the temperature fell far below this figure, so that a reading of 30,000 ft. on the aneroid might correspond perhaps to a real height of, say, 28,000 ft. In the early days of the war a speed of 55 miles an hour and the ability to climb 3,500 ft. in 10 minutes was considered a good result.

Of these early machines, the V.E. was interesting as the progenitor of the machines having automatic stability. In general, the early machines were very unstable, and if the pilot abandoned control would dive or turn upside down. A few months before the war Mr. T. E. Buss, working at Farnborough, had succeeded in securing automatic stability by giving the planes a slight dihedral angle and adjusting the distribution of wing and tail surfaces, relatively to the centre of gravity of the machine. It was, the lecturer said, a little doubtful whether this was actually the first automatically stable machine, or whether the honour lay with the Dunn machine. It was not certain, however, whether the latter was really stable in the modern sense of the term, but it was in any case a very uncomfortable machine and not really practical.

The mathematical theory of aeroplane stability had been originated by Bryan who showed that the stability could be calculated if we knew 18 quantities known as the resistance derivatives, depending on the form, speed and angle of attack, and on the weight, moment of inertia, and on the position of the centre of gravity of the machine. The calculation was, however, very difficult, and this was true also of the experimental work involved. Nevertheless it was now possible to state definitely before construction whether a proposed machine would or would not be stable.

A machine, the lecturer proceeded, might be out of trim without being unstable. An unstable machine had no special tendency to go over in any definite direction, whilst with a machine out of trim there was such a definite direction. The out of balance might for example be due to the tail plane carrying less than its proper proportion of the total load. If the centre of gravity of the machine was at one-tenth the distance between the centre of pressure of the wing surfaces and of the tail plane, the latter should be set at such an angle that in level flight the tail took one-tenth of the total load. If it were not so set the machine could nevertheless still be made to fly by pulling over the elevator.

The lecturer illustrated the effects of alterations in the position of the centre of gravity of a machine by means of mica gliders, which, he stated, were originated by Lanchester and had been further developed by Bairstow. When properly adjusted these models would, it was shown, glide steadily, however launched, whilst in other cases they dived or turned over.

Bryan, the speaker continued, had shown that the problem of aeroplane stability could be divided into two parts. In the one, the case of longitudinal stability was discussed, and in the other questions of lateral stability. For computing longitudinal stability it was necessary to know nine of Bryan's derivatives. Speaking roughly, however, we might look on an aeroplane as equivalent to a weather-cock placed horizontally, the pivot corresponding to the centre of gravity of the aeroplane. For longitudinal stability it would be obvious from this analogy, that the centre of gravity should be as far forward as practicable.

When a longitudinally stable glider was launched its flight path in general oscillated about that corresponding to its gliding angle and the same phenomenon was observed with actual aeroplanes. This is illustrated by Fig. 3, which represented the "phugoid" curves observed with the R.E. 8 machine. The term phugoid was due to Lanchester, who had first studied these flight curves. The curves in Fig. 3 had been plotted from observations of the speed taken every 5 seconds on an aeroplane traversing a phugoid path. In the cases shown there was, it would be seen, a considerable damping effect. But with large machines this was slow. The reason for this was not entirely understood.

Speaking generally, when a glider was travelling at a speed greater than that corresponding to the natural gliding angle the lift on the wings overbalanced the lift on the tail, and the nose was thus caused to point up. The machine rose accordingly, and as the speed fell off a point was reached at which the pressure on the tail overbalanced that on the wing planes, and the nose was then turned down. In travelling down, the machine again acquired a speed higher than that corresponding to the glide angle, and the cycle already described was repeated. If there were no damping these oscillations would continue indefinitely. The further forward the centre of gravity of a glider, the more rapid were the oscillations. As the centre of gravity was moved back these oscillations became slower, and of greater amplitude. Finally, if the backward shift of the centre of gravity exceeded a certain limit, there was no oscillation, and longitudinal stability disappeared.

PARAFFIN WAX AND ITS MANUFACTURE.

WAXES form a natural group of substances well characterised by their physical properties, but chemically of widely varying constitutions. Like the oils and fats to which they are closely related, waxes may be of vegetable and animal origin; the mineral waxes probably belong to either of these classes. Crystalline substances, hard and brittle at ordinary temperature, the waxes may soften already in the heat of a summer's day; otherwise they are remarkably stable and indifferent to atmospheric influences and chemically very resistant, and they have neither taste nor odour. For these reasons they have found varied industrial uses; they make candles and tapers; matches are dipped into molten wax; leather, cloth, paper are waterproofed with it; wooden casks are internally coated with wax not to impart a taste to the liquids in them; waxes are used for keeping the rust off metals and germs off food preserves; they are constituents of polishes for boots and floors as well as of chocolate creams, and paraffin wax has long become very useful to naval architects as a material for shaping ships' models. Chemically, waxes may be very complex alcohols, fatty acids, esters, &c., or simply hydrocarbons. The paraffin waxes, with which Mr. A. Campbell, F.I.C., and Mr. W. J. Wilson dealt in a paper on "Paraffin Wax and its Manufacture," read before the Institution of Petroleum Technologists on January 21, are saturated hydrocarbons of the composition $C_n H_{2n+2}$. The lower members of this series are methane, ethane, propane, &c., the gaseous and liquid constituents of natural oils, while the higher members, from $C_{17}H_{36}$ upward, form the paraffin waxes, often called paraffins simply. Like the gases and liquid hydrocarbons mentioned they are isolated by the distillation of petroleum, shales, lignites, and their manufacture and industry are hence intimately allied with the oil industry. By distilling these materials, and shales and lignites in particular, partly with the aid of steam, we obtain successfully spirit or naphtha (solvent and motor fuel), burning oil for lamps, intermediate oils for gas making, cleaning, lubrication and engine fuel, and solid paraffin, in addition to the residue, coke, and the by-products, tar and ammonia.

Though Lord Dundonald experimented on distillation of Scottish shales about 1780, it was not till 1850 that James Young established the shale-oil industry in Scotland. Meanwhile, however, mineral fats and waxes had been isolated by Fuchs in 1809, from a Bavarian petroleum; Reichenbach had introduced the name paraffin (a substance of little affinity) in 1830, British chemists had studied Rangoon oils, wax had been manufactured on a small scale in France, and the candle manufacture had been patented. Scottish paraffin, first supplied by W. Brown and Co., of Glasgow, commanded the market until the American and Galician petroleum industry developed. Messrs. Price's Candle Company, of Battersea, worked Burmah oil for candles, lubricants and illuminants early in the fifties, and exported it to America. At the present time something like 350,000 tons of paraffin are produced annually by distillation according to Mr. Campbell; at 3*d*. per pound that would represent a sum of 10,000,000*l*. Most of this wax is utilised in the candle and match industries. The natural oils differ much in their paraffin contents. Baku oil is almost free of wax; American oil contains 2 per cent. or 3 per cent., Galician petroleum 5 per cent. or 6 per cent.; in Assam and Burmah oil the percentage rises to 12, lignites are equally rich, and Scottish crude oil contains up to 11 per cent. of paraffin; oils from Borneo and Persia are also valuable sources of paraffin, but hardly exploited so far. Most of the wax comes from America owing to the huge scale of the petroleum industry of that country. The development of the German lignite-paraffin industry also dates back to the fifties.

Paraffin does not assume the crystalline form, which ensures its easy separation from the oil with which it is associated, until distillation takes place. It usually comes over after the kerosene fraction, and the melting-points of the scales obtained rise as the end of the distillation is reached. In the presence of asphaltic matter the distillation has to be repeated and the distillate to be treated with sulphuric acid. The manufacture of paraffin proper begins with the cooling of the vapours and the separation of the scales; the refining is mostly carried out by a "sweating" process, and is a problem for the engineer rather than for the chemist. Having dealt with the refining of petroleum before the same Institution two years ago, Mr. A. Campbell confined himself in the paper quoted to the relatively simple refining of paraffin. The paraffin which solidifies is a mixture of many paraffins to which a great deal of oily matter adheres. When the chemist wishes to purify crops of crystals he presses them between pieces of filter paper and washes them with solvents for the impurities, being prepared to

sacrifice part of his crop, which will be absorbed by the paper. He also resorts to partial fusion. The sweating process is of the fusion type. To hasten the solidification, however, the distillate has in the first instance to be cooled, by air or by brine. This was in the early days done in shallow pans; the solidified mass was then shovelled into bags which were drained and then submitted to pressure; the filtrate was once more cooled to gain the "soft scale," the first product being the "hard scale." In the old drum cooler, cold brine circulated through a drum slowly revolving in the liquid, the solid settling on the drum being scraped off. This chilling was frequently too rapid, and the product was difficult to purify by subsequent filtering in the press or through fuller's earth or other material. In the later apparatus the cooling is external, the vessels being cylinders or tanks of large surfaces, through and over which the liquid passes continuously. These coolers are mainly of the Henderson, Bryson and Thomson types. A G. N. Henderson cooler will cool 2,400 gallons from 84 deg. F. down to 35 deg. in 24 hours, with brine at 13 deg., and 1,500 gallons of *a* paraffin distillate of 120 deg. can be reduced to 40 deg. by brine of 16 deg.; these are examples given by Mr. Campbell; the figures are much influenced by the viscosity of the oil, of course. At the Oakbank Oil Works, Beilby introduced, in the eighties, for a very viscous oil, cells of the type of ice-boxes, 8 ft. deep, 16 ft. long, 1 ft. wide, slightly tapering; the oil was allowed to freeze for three days, and the solid paraffin then forced out by means of a helix, extending at the bottom of the cell from end to end. In the Thomson process later adopted there, the heavy oil is, as Sir Boverton Redwood explained during the discussion, first run through a tower where it meets air from a blower; it then passes through an annular water cooler fitted with scrapers, further, through a similar cooler, where it is cooled by the cold oil from the filter presses, and is finally pumped direct through the anhydrous ammonia cooler to the filter presses. The temperature in the ammonia cooler is gradually lowered, as the liquid passes from the top inlet to the bottom outlet.

The purification of the paraffin scale was first effected on laboratory lines by spreading the scales on and between absorbent materials and submitting them to pressure and also by washing them with solvents to remove oils adhering to the surface. In 1871, John Hodges cast the scales into cakes, placed them on a bed of absorbent material (dry sand, cloth, filter paper) and heated the whole in ovens by means of steam which played directly upon the paraffin. Subsequently the sweating was carried out on inclined shelves of corrugated iron covered with coir matting, and the steam was sent through coils. Tervet and Allison ran the melted crude paraffin into pans upon bands of cotton canvas or used vertical sweating cells made of gauze or perforated metal. James and William Baxter placed the cakes on edge inside perforated cases fixed to parallel endless chains. In the cylindrical sweating stoves and the trays of Henderson both the filling-in and the removal of the paraffin are carried out in the liquid state. In the Bayonne refinery of the Standard Oil Company, in New Jersey, the paraffin is cooled down to ointment consistency in horizontal drums, and the fused mass then run into shallow pans of huge dimensions, 30 m. long, 6 m. wide, and 15 cm. deep, surrounded by the steam coils. The oils sweated out are treated with concentrated sulphuric acid and bleaching agents; they are utilised as light lubricating materials and submitted to continuous circulation and distillation in stills arranged in step fashion. Mr. Campbell also mentioned the Whiting plant (not on the Henderson plan) of the same company in which sweating is carried out in cylindrical tanks of 40,000 gallons capacity with the aid of vertical hot-water pipes.

A mixture of hard and soft scale of melting-point 127 deg. F., *e.g.*, he further stated, would require 24 hours' cooling and 35 hours' sweating to yield 31·5 per cent. of the white wax, 59·5 per cent. of yellow, and 9 per cent. of soft sweating, the melting-points of the products being respectively 138 deg., 120 deg., 100 deg. F. Generally speaking, the tray form of sweating stove required 58 hours for the complete cycle of operations. Mr. Campbell referred to two recent suggestions. Edeleana goes back to a washing process, but he treats the scale with a solution of unsaturated hydrocarbons in sulphurous acid, which is an important reagent in the purification of oils. S. N. Dickie fuses all the scale obtained at low temperature and pumps it through nozzles against a current of cold air into centrifugal drums with wire-gauze walls of fine mesh in order to separate the atomised and solidified grains of wax from the oil. The suggestion looks tempting, but Dr. Dunston expressed the opinion that the cooling would be too rapid.

Mr. A. Campbell, who is an authority in this field, illustrated many of the devices mentioned by slides, which were all the more interesting as very little is published on this subject. His particular point was whether the hard scale and the soft scale should be sweated separately, or the mixture should be sweated as such. The former method might be expected to produce the better yield of white wax, which is relatively of higher value than the yellow wax. The detailed account of the experiments made by Messrs. Campbell and Wilson with various mixtures of hard scales (melting at 129 deg. F.) and soft scales (melting-point 113 deg. F.), sweated for different periods and at different temperatures, appears, however, to demonstrate the superiority of sweating the mixed fractions over the method of sweating the fractions separately. There was also a decided gain in time by sweating the total scale; in one case the sweating period was reduced from 30 hours to 16 hours by treating the whole mass instead of dealing separately with fractions of the hard scale and soft scale. Dr. L. Lomax, who said during the discussion that he had himself found that a fairly wide range of fractions and slow raising of the temperature were necessary for successful sweating, was ready to accept this conclusion. Mr. Campbell further pointed out that careful distillation was most essential for good extraction; heavy oils and paraffin were at present run with a good supply of dry steam, not particularly superheated, with a vacuum of 20 in. or 22 in., in order to obtain good results right to the end of the distillation.

The final process in wax production is always said to consist in stirring 1 per cent. or 2 per cent. of charcoal into the fused wax, leaving it in contact with the char for about 15 minutes and then filtering through cloth. According to Mabery the commercial paraffins from Pennsylvania oil range, as Mr. Campbell stated, in formula form $C_{17}H_{36}$ up to $C_{35}H_{72}$, and in melting-points from 10 deg. up to 76 deg. C. (50 deg. to 169 deg. F.). The ordinary candle is either stearin (melting at 130·5 deg. F.) or a mixture of commercial stearin and paraffin (melting at 133 deg. F.); the melting-points of the mixtures are below those of both the contituents. The addition of stearin to paraffin makes the candles stiffer and raises the bending-point though slightly lowering the candle-power. Whether the bulk of the paraffin production will continue to go into the candle manufacture remains to be seen.

Tour of Brazilian Delegates in Great Britain.—With the object of strengthening the business and personal relations between Great Britain and Brazil, the Federation of British Industries has invited to this country a delegation of representative Brazilian business men. It may be recalled that this organisation was responsible for the visit of a body of Greek commercial men to the United Kingdom in the autumn of last year. The reasons influencing the Federation of British Industries to select Brazil in the first instance from among the Latin-American republics may be very shortly stated. Brazil's area alone, covering more than half South America, entitles her to this preference, apart from the moral influence exercised in that Continent by her wholehearted challenge to Germany at an early and critical stage of the war. With a view to considering the representative industries of both countries which would best profit by the tour, it has been decided that Mr. W. S. Barclay, who was loaned by the federation to Sir Maurice de Bunsen's Mission to South America during last summer, should proceed to Brazil and spend a few weeks there before conducting the delegates to this country. It has also been arranged, by courtesy of the Department of Overseas Trade, that Mr. Hambloch, H.M. Commercial Attaché in Brazil, shall accompany the party to this country and throughout their tour, a fact which will be of very great advantage to the delegates. Mr. Barclay will sail for Brazil on April 5, and will arrange for the tour to begin in this country not later than June 15.

INDUSTRIAL NOTES.

Mr. F. H. McLeod, Director of the Department of Labour Statistics, states in *The Labour Gazette*, that employment in January showed a further decline, whether tested by the trade union percentages or by the number in receipt of the Government out-of-work donation or by the records of the Employment Exchanges.

Trade unions with a net membership of 1,141,767, excluding those serving with the Forces, reported 2·5 per cent. of their members as unemployed at the end of January, as compared with 1·2 per cent. at the end of December and 1·0 per cent. a year ago.

Of the 3,561,710 male and female workpeople insured against unemployment under the Acts of 1911 and 1916, the number unemployed at the end of January was 353,647 (or 9·93 per cent.), compared with 6·71 per cent. for January 3, 1919, and 0·88 per cent. on January 25, 1918. For males and females separately the percentages unemployed at the end of January were 6·08 and 20·58. In addition to these 353,647 workpeople, there were 325,056 persons (95,376 men and boys and 229,680 women and girls) in occupations not included under the National Insurance Acts who were unemployed on January 31.

Excluding demobilised members of His Majesty's Forces, the number of persons who were unemployed on each Friday in January, according to the statistics of the Government out-of-work donation scheme, was as follows: January 3, 356,707; January 10, 417,621; January 17, 479,075; January 24, 543,215; January 31 625,149. The number of demobilised members of His Majesty's Forces in receipt of out-of-work donation at the end of January was 53,554.

The number of men on the live registers of the Employment Exchanges on January 31 was 273,876, and the number of women was 453,912. The corresponding figures for January 3 were 166,603 and 279,078. The number of vacancies unfilled on January 31 was 67,318 for men and 51,881 for women, the corresponding figures for January 3 being 73,740 and 39,510.

The changes in rates of wages (including war bonuses) reported to the department as having come into operation in January, to take effect either in that month, or from earlier dates, resulted in a net increase of 60,000*l.* in the weekly wages of about 250,000 workpeople. The principal changes were advances of 5*s.* and 2*s.* 6*d.* respectively per week to women and girls in the engineering trade, and advances, varying from 7½ per cent. to 34½ per cent. on pre-war wages, to tinplate workers in South Wales and Monmouthshire.

Reductions in hours of labour taking effect in January affected over 1,600,000 workpeople, whose recognised hours were reduced by an aggregate of 10,500,000 per week. These reductions affected, amongst others, all classes of workpeople in the engineering and shipbuilding trades and workpeople in some of the principal other metal trades, for whom a uniform week of 47 hours was arranged, and surface workers in all the principal coalfields, whose hours were reduced to a uniform week of 49 hours. Further reductions took effect early in February, including that resulting from the adoption of the principle of a working day of 8 hours for railway servants.

The number of trade disputes beginning in January was 105, and the total number of workpeople involved in all disputes in progress was about 460,000, as compared with 150,000 in the previous month, and 93,000 in January, 1918. The estimated aggregate duration of all trade disputes during the month was 2,918,000 days, as compared with 1,174,000 days in December, 1918, and 533,000 days in January, 1918.

According to *The London and China Telegraph*, the China labour force in France has proved such a success that it is not surprising that it should be in contemplation to retain it to assist in the work of reconstruction in the devastated areas. The Chinese Minister in Paris has made a representation to his Government on the subject, and it is believed there will be no difficulty in making the necessary arrangements. This request from France is regarded as another testimony to the splendid character of the work by Chinese during the war. They have proved themselves tireless and enduring workers, and have shown remarkable courage under shell fire. It is probable that Chinese already in Europe will be retained in part for the reconstruction work instead of new recruits being sent. So far, the only Chinese labourers returned have been a few hundred, who were ill or wounded in German air raids. These returned labourers, though ill, were all enthusiastic about their experience and about the treatment they received while in service.

The Ministry of Labour has announced that the Government have had under consideration the industrial unrest which has recently manifested itself in various districts, and they have decided to call a National Industrial Conference at which members of the Government can have an opportunity of meeting

representatives of the industries of the country so that the general situation may be discussed and the views of the representatives of employers and workpeople ascertained.

The conference is to be held at the Central Hall, Westminster, on Thursday, the 27th inst., at 10.30 a.m.

The arrangements for the meeting are in the hands of the Ministry of Labour, Montagu House. Admission will be by ticket only. Invitations are being issued to all Joint Industrial Councils and Interim Industrial Reconstruction Committees, asking them to arrange for the attendance of the chairman and vice-chairman of the council or committee, together with two other members. The intention is that, as far as possible, the industries of the country be represented through their Industrial Councils or Reconstruction Committees, but in industries where such councils or committees do not exist, invitations are being addressed direct to the organisations most fully representing the employers and workpeople respectively.

It is desired that the conference be as fully representative as possible, but owing to the limits of accommodation it is necessary for invitations to be restricted generally to organisations which represent most widely the interests of the industrial community.

The Ministry of Labour strongly urge employers to notify their requirements for any class of labour to the nearest Exchange or employment office. If such offices are informed by employers of all vacancies of any kind, it is possible for them to offer suitable employment to applicants for out-of-work donation, whereas without this information it is possible that donations will be paid to people who are not entitled to receive it.

Employers, therefore, can materially assist both themselves and the Exchanges at the present juncture by notifying all vacancies of any kind.

A leaflet has been issued by the Ministry of Labour. It is entitled "Industrial Councils. The Recommendations of the Whitley Report." It states that the Joint Industrial Councils were unanimously recommended by a committee appointed by Mr. Asquith to advise the Cabinet on the future relations of employers and employed. It gives the names of the members of the committee, the objects of the Whitley Report, the constitution of Industrial Councils, &c. The leaflet is marked H.Q. 7 B.

Statements having been made to the effect that the ballot paper circulated to the members of the Miners' Federation contains a statement that the Government have "failed to grant" the miners' demands, the Minister of Labour, on behalf of the Government, addressed last Saturday the following letter to Mr. Smillie, president of the Miners' Federation:—

"My attention has been called to a statement which has appeared in the Press to the effect that the ballot paper which is being circulated by the federation states shortly the four proposals made to the Government by the miners, and adds: 'The Government having failed to grant the above proposals, are you in favour of a national strike, Yes or No?'

"I do not know whether the Press statement correctly describes the form of the ballot paper, but I would point out, on behalf of the Government, that it is inaccurate to say that the Government have failed to grant the miners' proposals. On the contrary, so far as regards the part of the wages claim, which is based upon the increased cost of living, the Government have offered an immediate advance of wages of 6*s.* per week to meet the increase in the cost of living since the date of the miners' last advance, and they have made it clear that if the amount is disputed, or if it is claimed that the figures upon which the sum is reached are not accepted, the Government are prepared to leave it to be adjusted by an independent tribunal.

"Again, so far as regards the miners' claim for an increase in wages to secure an improved standard of life and for a shorter working day, the Government have not 'failed to grant the miners' proposals'; the reply of the Government is that they fully sympathise with the desire of the miners for an improved standard of living, but that as the claims submitted necessarily involve far-reaching consequences to the whole community, including the miners themselves, it is essential that there should be an investigation to ascertain the facts. They have expressed their intention to set up a committee to make this inquiry without delay and to ask the miners to select representatives to act as members of it.

"Similarly with regard to nationalisation of the mines the Government have not expressed any view in opposition to the miners' proposals; their opinion is that a decision cannot be given, and ought not to be given, on a question of this magnitude and importance until there has been an opportunity to inquire into the subject in its various aspects and until the Government and the country have before them the results of an examination made by a competent body.

"I venture to suggest to you that the members of your federation are entitled to have before them on the ballot paper, not only a statement of the terms proposed by you, but also a correct account of the attitude of the Government towards these proposals."

We dealt with the miners claims on page 218 *ante*.

The report for the current month issued by the Steam Engine Makers' Society states that the membership is now 26,000 and the capital 260,000*l*. The report strongly appeals to all the members throughout the country to come out into the open and defeat all those who make loud professions, not a few of whom bear foreign names, and who have deliberately set to work not only to wreck organised society but also trade unionism. The events in London, in Belfast and on the Clyde can obviously have but one ending, namely defeat. There is danger ahead for the *bona fide* trade unionists, who, acting in combination upon the basis of discipline and order have long since proved their worth both to the State and to industry. No progress, adds the report, can be made by mob rule, revolutionary ravings and the resultant "sabotage"; and while there is yet time, all right-thinking and loyal members of the Steam Engine Makers' Society and of all other trade unions are urgently requested to combine with a view to seeing that "the citadel of freedom and progress be not irretrievably wrecked, as it undoubtedly will be if the lines of self-discipline and order be not at once resumed."

The National Council of the Commercial Motor Users' Association (Incorporated) has been informed that the Government will shortly require employers to join a suitable federation in order to regularise dealings with labour. The council has accordingly entered into an arrangement with the Motor Transport Employers' Federation, under which the new conditions can be met by haulage contractors and other owners of commercial motor wagons or vans. Captain F. G. Bristow, who is secretary to the two bodies, can be addressed at 83, Pall Mall, London, S.W. 1, for fuller information.

SHORTAGE OF IRON ORE IN GERMANY.—The absence of supplies of minette ore, coupled with the gradual consumption of existing stocks, has already made itself seriously felt at several iron works, more especially at such which almost exclusively used minette ore and where the supply of available ore from other quarters is either curtailed or stopped owing to transport difficulties. Thus the Rhenish Steel Works, Duisburg, have been compelled to close down a part of their shops which utilised the power generated by steam obtained from the waste heat from their smelting furnaces. The reduction in the output of pig-iron and other products is fairly tangible. At some works the supplies of ore, including Swedish ore, are somewhat larger, but the necessity for Germany of arriving at a speedy understanding with France in regard to prompt deliveries of minette ore becomes more and more evident. The supply of ore from the Siegerland and neighbouring districts also leaves much to be desired as far as the iron works on the Ruhr are concerned.

NAVAL HONOURS.—The following honours have, with the approval of His Majesty the King, been conferred upon naval engineers, among others:—For valuable services in effecting repairs to H.M.S. Tedworth, a Membership of the Order of the British Empire has been conferred upon Acting-Artificer Engineer H. J. Northey, R.N. For services in action with enemy submarines: To receive the Distinguished Service Cross: Chief Artificer Engineer F. J. Baker, R.N. To receive the Distinguished Service Medal: Engine-Room Artificer G. U. Reid, R.N.V.R. To receive a Bar to the Distinguished Service Medal: Chief Engine-Room Artificers J. C. Addison, R.N.R., and W. L. Milton. For services in mine-sweeping operations:—To receive the Distinguished Service Cross: Engineer-Lieutenant C. F. Holt, R.N.R. For services in Monitors off the Belgian Coast between July 1 and November 11, 1918: Mentioned in Despatches: Chief Electrical Artificer J. B. Hutchings, Chief Engine-Room Artificer R. F. Taylor, R.N.R. For miscellaneous services: To receive the Meritorious Service Medal: Chief Engine-Room Artificer W. J. McCleery, D.S.M., R.N.R., and Engine-Room Artificer J. H. Robson. Mentioned in Despatches: Engineer-Commander J. B. Pulliblank, D.S.O., R.N. For services in cruisers employed on escort, convoy and patrol duties: To receive the Meritorious Service Medal: Chief Engine-Room Artificers George Francis, W. H. Hicks, W. J. Howell, George Elliott, G. F. Lockwood, and H. J. Northey, and Engine-Room Artificer Tom Appleby, R.N.R. For services in the Mediterranean Station: To receive the Meritorious Service Medal: Chief Electrical Artificer R. J. L. Keith; Chief Engine-Room Artificers William Vivian, T. F. Bevan, R.N.R., and M. P. Warren; Engine-Room Artificers J. J. Beckwith, O. G. Martin, W. G. R. Eldridge, Claudius Haslam, A. C. Rundle, W. N. Enslie, John Thackray, and Allan Waining. For services in the mercantile marine: To receive the Distinguished Service Cross: Chief Engineers George Cockburn and John Blanchflower, and Third Engineer William Craig. The President of the Portuguese Republic has been pleased to confer the Military Order of Avis upon Engineer-Lieutenants R. A. Steer, R.N., and John Mann, R.N.

THE FEDERATION OF BRITISH INDUSTRIES.

A MEMORANDUM from the Provisional Committee of the British Manufacturers' Corporation sent out this week to firms associated with the corporation describes interesting developments in connection with Sir Charles Mandleberg's scheme for the expansion of the British export trade. Those proposals attracted considerable interest and obtained substantial support among business men when they were put forward a little over a year ago. It will be recollected that in September last a representative meeting of manufacturers held in Manchester resolved to form an organisation to carry the plan into effect, and a provisional committee was appointed, with Sir Charles Mandleberg as chairman, to bring the British Manufacturers' Corporation into being for that purpose. Over 300 firms in England, Scotland and Ireland had agreed to be associated with the proposals, forming a substantial nucleus for the new organisation, and a couple of months' spadework in committee resulted in concrete proposals being ready for submission to the associated firms. Matters had reached this stage when, towards the end of November, the committee were approached by the Federation of British Industries with a view to effecting a fusion with that organisation. The federation has a membership of over 800 individual manufacturing firms and about 170 trade associations. Its Overseas Trade Committee, desirous of a progressive overseas trade policy, reported that after careful consideration they had come to the conclusion that the principles first formulated in Sir Charles Mandleberg's scheme were sound, and that they had made them the basis of their own proposals. In these circumstances they thought it would be a great waste of energy and lead to overlapping if the scheme went through independently, and they suggested a fusion of the British Manufacturers' Corporation with the federation for the purpose of carrying out the schemes.

A general meeting of the federation, on December 12 approved the proposals, and as the result of the negotiations then opened conditions of fusion have been agreed upon by the respective committees, and these were to be submitted to a general meeting of the British Manufacturers' Corporation on February 20.

The terms of the proposed amalgamation make it clear that the export trade development policy on which the federation is about to embark is identical in essentials with the scheme first suggested by Sir Charles Mandleberg. It is proposed to appoint Commissioners in such foreign and colonial markets as may be determined, who will act for members of the organisation in various ways, such as appointing selling agents when requested to do so, protecting members' interests when desired, and taking prompt measures in emergencies. The Commissioner would necessarily be a British subject, with previous experience of the country to which he was appointed, and thoroughly acquainted with the language, the commercial needs and the trading customs of its people—in short, he would be a man of high commercial standing, comparable to the principal of an important business. His functions would include the collecting and classifying, with the aid of a staff, of the trade information from that area likely to be of use to British manufacturers; reporting on foreign competitors' activities; acting for members in a legal capacity when necessary in the protection of their interests; reporting on the financial status of local firms; and advising members on such matters as import duties, methods and cost of transport, local labour conditions and wage-rates, &c. At home, an important feature of the scheme will be the organisation of the federation's branch offices throughout the country as centres at which all necessary information on export trade routine can be promptly obtained by members.

An annual subscription of 100*l*. entitled British Manufacturers' Corporation firms to this Overseas Commissioner service, as well as to the other services which the federation already renders to members. Under the agreement the British Manufacturers' Corporation is to have immediate and substantial representation on the committee that will administer the scheme. The Provisional Committee of the British Manufacturers' Corporation in their memorandum state that they have been largely influenced in their decision to recommend fusion by their belief that under the conditions arranged the Commissioner service will be carried out in the spirit in which the proposals were first drafted by Sir Charles Mandleberg and afterwards adopted by the British Manufacturers' Corporation as a hopeful and practical working policy for the speedy expansion of the British export trade.

IMPORT RESTRICTIONS.—The Federation of British Industries are pressing on the Government the absolute necessity of not allowing products which compete with those of any industry in this country to be imported and sold at prices with which existing conditions make it impossible for the home industry to compete, until that industry has had a reasonable opportunity of converting from a war to a peace footing. The federation realises that pressure may be brought to bear upon the British Government by foreign Governments who desire to import into this country, but such considerations appear to them to be infinitely less important than that cited. Further, they point out that the decision of the questions which arise in connection with the raising of restrictions and granting of licences often involves very minute inquiries into the available and potential supplies of small articles. These inquiries can most satisfactorily be made through an organisation such as the federation, which comprises manufacturers in every branch of industry and has collected very full statistics as to the products of the various industries.

NAVAL ENGINEERS.

To the Editor of Engineering.

Sir,—When the future historian of naval engineering comes to search your pages for information as to the progress and advancement of the naval engineer, he will find himself confronted with many scores of articles and hundreds of letters which, spread over half a century or more, illustrate the rugged path the engineer has had to climb while striving to gain his goal. And among this material the historian will find your comments on the famous letter of Sir Edward Reed to *The Times* of January 19, 1877, in which he summed up the man-of-war and the naval engineer of that time. "Every war vessel," wrote Reed, "is now a steamer, and some of our most powerful and valuable ships have not a sail upon them; but, on the contrary, are huge engines of war, animated and put into activity in every part by steam and steam alone. The main propelling engines are worked by steam; a separate steam engine starts and stops them; steam ventilates the monster; steam weighs the anchor; steam steers her; steam pumps her out if she leaks; steam loads the gun; steam trains it; steam elevates and depresses it; the ship is a steam being, and the only man who understands it, can work it with safety, can control it efficiently, can use it, care for it, tend it, preserve it, repair it, renew it, is the engineer," and yet, Reed went on to say, "the engineer is to-day almost precisely where he was twenty years ago, a snubbed, subdued and subordinated man, with a dozen officers put above him to look down upon him, and keep him in the inferior place which the Admiralty has assigned to him." Even *The Times* had to admit the justice of Reed's strictures, and agreed that the position of the engineer was one of the "great blots on the naval system." Since 1877 many changes have taken place, and though the question of staffing our engine-rooms is by no means done with, the old type of engineer officer who received his training in Keyham College has little to complain of as regards pay and status. His has indeed been a stormy career, and what under other circumstances might perhaps have been the

"last scene of all
"That ends this strange, eventful history,"

is well worth recording, as it is typical of many other things which have happened during the last eighty years.

The part of the story we now come to begins about fifteen years ago, and it runs something like this: "Once upon a time the two great men who ruled the King's Navee wished to make everybody happy—at least some thought they did—and so at Christmas time in the year 1902 they caused Santa Claus to put into the Navy's stocking a wonderful paper which, while it showed a delightful ignorance of human nature, made all sorts of nice promises, and above all it was going to make every naval officer 'a seaman, a gunner, a soldier, an engineer and a man of science." In fact, every naval officer was to be completely "Pelmanised." It was all so wonderful, that it was just as if these two great men had discovered one the philosopher's stone and the other the elixir of life. There were to be lots of promotion and lots of pay. Every one was to be a jack-of-all-trades, and even the engineers, who always appeared—at least in print—about as miserable as the "poor condemned English" before the battle of Agincourt, thought at last their luck had changed. But alas for all their rosy visions, for many of them were deceived by:

"The seeming truth which coming times put on
To entrap the wisest."

They forgot all about the wicked fairy in the piece, and so when the engineer-commanders expected 24*s.* a day on promotion they trusted too much to the two great men, for a few months later another paper came out, saying "Oh, this was only meant to refer to a favoured few," and so most of the engineer officers learnt once again that—

"All that glitters is not gold."

But the real Cinderellas in the story were the dozen or so of "assistant engineers for temporary service." The paper in the stocking distinctly said there was to be accelerated promotion, so that the "average period of reaching each rank will be assimilated as far as possible to that of the executive branch, so as to correct the present disparity of age"; but the "assistant engineers for temporary service" found that when the promotion ball opened they were not allowed to go, and like Cinderella they had the unhappy experience of seeing all the others go off and enjoy themselves while they were left behind. What the wicked fairy did this for no one seems to know, unless it was to keep these officers as object lessons to the boys at Osborne, to warn them what might happen if they dared to take up engineering. However that may be, someone at last seems to have scotched the wicked fairy, for not only have the engineer-commanders been granted at last their 24*s.* a day on promotion, but it has been found out that after all the nine surviving "assistant engineers for temporary service" are not such bad fellows after all; they may once have been ugly ducklings, but now they have turned into beautiful swans and are to be allowed to fly with their fellows. This story, Sir, of righted wrongs, is a part of the history of 1918. The "Tite Barnacle" who prevented the engineer-commanders from getting their 24*s.* a day on promotion fifteen years ago, at least has this to his credit, that he has saved something like 300,000*l.* to his country, but of the individual responsible for the treatment accorded the "assistant engineers for temporary service" the less said the better. He must have belonged to that category which you referred to in your recent suggestive article on "The Impossible Man."

The absence of late from your columns of any correspondence on the naval engineer question might lead some of your readers to think that nowadays everything is satisfactory, but recent events seem to show that once again the question will become acute, and that it is even now entering upon another cycle of operations like the ideal substance in Carnot's imaginary engine which, after having undergone various extraordinary changes, returns to its original state and begins its cycle once more. To-day there are, in the Navy, engineer officers trained at Keyham, engineer officers entered direct from works and colleges, engineer officers for temporary service entered from anywhere, commissioned officers promoted from warrant officers, commissioned officers promoted through the intermediate grade of mate and, last of all, the Selborne-Fisher-Ewing "observational" engineers, the lieutenants (E) who, coming from Osborne and Dartmouth, are to be regarded as the products of the attempt to combine in one person the attributes of "a seaman, a gunner, a soldier, an engineer and a man of science." But in spite of all these various brands of officers, what the naval rulers really think of the engineer is seen when it is stated that the Olympic, while under the White Ensign, could boast of 33 engineer officers with commissions, while the Tiger counts but three! Our largest battle cruisers, with a stoker battalion 600 strong, go into action with an engineer officer of the rank of lieutenant-colonel, another with the rank of major and a third with that of captain. It is not contended here that there is room for 33 commissioned engineer officers in our capital ships, but it is suggested that any officer capable of taking charge of a complete watch in the engine-room of such a ship is worthy of a commission, and that it is not right that the officer performing this important and onerous duty should bear the relative rank of a superior sergeant-major. A quarter of a century ago our big ships, our "Anson's" and our "Hood's" did muster five or six commissioned engineer officers, and that should be the position now. It may, however, be argued that during the war the engineering branch has at least done middling well, and that these things are best left alone. This attitude is entirely placed out of court by the fact that the famous "Jerram Committee" now sitting suddenly finds itself faced with the demands of the boy artificers to be called "engineer students" and to be entered as "assistant engineers," and seeing they are the only folk who are being trained by the Admiralty on anything like proper engineering lines, it is difficult to see that the demands can be altogether pushed aside. That they will be shelved for the time cannot be doubted, but aspirations like these cannot be stifled, and it looks as if the next ten years is going to see the old battle all over again. Whether the powers that be resolve to imitate the ostrich-like action of their predecessors and hide their heads in the sand, remains to be seen.

From the days when the Secretary of the Admiralty said "A dangerous set of projectors had supplied their Lordships with a whole fleet of *iron* steam vessels, altogether useless, it would seem, as ships of war," and Admiral Symonds did his utmost to prevent Brunel introducing the screw-propeller, past the time when inspectors of machinery were considered well paid at a pound a day and Admiral Hoskins could with impunity compare the engineer to a lascar with a bottle of oil, the history of the naval engineer question is a series of bitter controversies, niggardly concessions and belated reforms; while the twentieth century saw the greatest blunder of all—the closing of the Royal Naval Engineering College at Keyham. Whatever is done now, engineering in the Navy for the next twenty years will be largely in the hands of the boys who have passed through the Indus and Fisgard and every member of the engineering profession will sympathise with their ambitions and wish them success in their efforts to gain the status which is compatible with the important duties they are called upon to perform.

Yours, &c.,
"An Engineer."

CIVIL AERIAL TRANSPORT.

To the Editor of Engineering.

Sir,—In your issue of Engineering of February 7th, 1919, appears an article by Sir George Greenhill; having recently been engaged on the problem of economical flight I read it with great interest, and though his results seem to come near the truth in the examples he gives of the Handley-Page machine, this is chiefly so because of an arithmetical error.

In the first place let me put in a plea for old dame Nature. "On the sine law the lift is found to be ample for ascent into the air, and the flying machine is to-day a practical justification of this new Helmholtz-Kirchhoff theory," says the author. This seems to imply that we can fly to-day because of the theory. Would flight be impossible without the theory? It seems so, for as long as we held to the theory of that not unknown "ancient," to wit Newton, flight was impossible.

The petrol consumption is worked out under certain definite assumptions: the weight, speed, attitude and altitude must be constant and this is clearly impossible. To make an allowance for loss of weight we are told that the range L must be multiplied by $\frac{W}{W-P}$.

Now $L = \frac{330\,n\,P}{2\,W\,P}$ and the correction merely implies then that the whole journey is made with the final instead of the initial weight, the former fallacy remaining.

With regard to the Handley-Page example there are the following weaknesses:—

Correcting the obvious slip $\frac{W}{A} = \frac{13\frac{1}{2} \times 2,240}{2,500}$ we get $\frac{W}{A} = \frac{6\frac{1}{2} \times 2,240}{2,500}$, and this = 5·8, not nearly 5.

K now becomes 91 and H.P. 810.

This H.P. too is the effective horse power and not the H.P. developed by the engines; even with as high an efficiency as 81 per cent. the result gives us 1,000 as the engine power, as against the 700 actual.

Let me too put in a plea for sanity: why, oh why should knots and nautical miles, kilometres and kilometres per hour be sane and miles and miles per hour be insane? If statute miles are forbidden why may feet be used? Further fallacies appear in the paragraph of air density. This is not halved until a height of greater than 20,000 feet is attained, and when it is the flight speed K would be changed to $\sqrt{2}$ K, not 2 K as the author states.

Under his conditions the range of flight is unaffected by height, which is contrary to experience. Within the limits of a possible speed range we may say that the greater the speed the greater the efficiency of the propeller and therefore the smaller the petrol consumption for a given effective horse power. The range for a given weight of petrol may be increased by an amount up to 5 per cent. by choosing a flight path 10,000 feet higher.

Yours faithfully,
O. Glauert.

9, Waverley Road, Norwich,
Feb. 14, 1919.

LABOUR UNREST.

To the Editor of Engineering.

Sir,—I have read quite a number of prominent opinions regarding our position in the world's market at the present time and our inability of cheap production to enable us favourably to compete with foreign trade, but nowhere have I seen offered a definite solution to this problem. We have in Britain to-day opportunities in trade and commerce which we or our people for generations before us could never have dreamt of. The possibilities presented now give us the chance of becoming one of the largest producers, and the opening is here for building a nation financially and industrially stronger than ever. In the meantime, we are undoubtedly throwing away our most valuable time owing to the industrial unrest and the seething discontent of the majority of workers, and there is no possible shadow of doubt that this is becoming increasingly alarming, and I am afraid is going to be very much worse in the near future when demobilisation is complete. I wish to state that I hold no brief for either employer or employee; but at the present time the high cost of almost every commodity of life is, to say the least, most irritating to people of ordinary incomes, and is not conducive to either rest or contentment in the workman. The whole system of relations of employer and employee must be changed. The great gulf between employer and employee must be bridged, and that very quickly. Our system of management must assume a more cordial and sympathetic attitude to the workers and officialism must be curtailed. I do not mean by this that the worker is to be pandered to by any means, or that he is to be placed in a position of the absolutely indispensable and allowed to do as he likes; but a compact must be made and loyally kept by both parties. The workmen must give a good day's work for a good day's pay. Personally, I have always found this method to prove most satisfactory and profitable, and in very few cases where the trust has been placed in the workman have I had cause to regret it. Of course, there are exceptional cases, such as bad timekeeping, laziness, &c.; in such cases, the matter being proved to my satisfaction, has resulted in instant dismissal. Give the worker something to work for worth working for—a feeling of security and a job worth looking after, and I am sure you will find the results highly satisfactory.

This is a difficult matter to deal with. Our present position is that with restrictions of trade unions on the workman's side and the hard and bad bargain on the employer's side, the best results are not obtained. I make bold to say that 35 per cent. to 40 per cent. more work could be done by the workman without detriment to health than is done to-day, but in the majority of cases if this was to be done by the worker the price of the work is invariably cut down or pressure brought to bear to speed-up all workmen concerned, some of whom are not as expert as others.

Now I contend that this is entirely wrong, and is the cause of the feeling that the employer is eagerly waiting to squeeze the workman on the slightest pretence, and consequently the attitude of the worker to the employer is anything but cordial.

Alter this, and you will find that more beneficial results follow a feeling of security, satisfaction and mutual respect for both sides. To give an instance of this, a few days ago, after numerous consultations between employers and trade union officials, a referendum was taken on the 47-hour week; this eventually, after considerable expense, was agreed to; but what do we find? No sooner had the new agreement been adopted than the officials pounced on the men, the 10 minutes hitherto recognised as a break for refreshment being immediately cut off (not that the officials concerned were not quite justified in their attitude and were quite within their rights); the result, however, was another strike, and the whole work to go over again, thus wasting valuable time, irritating the workers, and we wonder why it is that we are losing so much ground. Really it seems to me that this matter could have been handled in a very much more satisfactory manner by the officials concerned, for even if the men did lose 10 minutes they could have easily made it up, and I have no doubt would have done so had the case been handled a little more diplomatically; and in the meantime we are losing our prospects of foreign trade and our possibilities of becoming one of the largest producers in the world. Can we wonder at it? But instead, we are causing increased industrial unrest and sure drifting into chaos,

the result of which is not very far to see—revolution, and possibly much worse.

Let us be warned in time; this is a very serious matter and the question of industrial unrest has got to be settled; it is a proposition which is increasing in importance daily, and must be faced squarely and a satisfactory solution arrived at. There will shortly be possibly 2,000,000 to 3,000,000 men coming back from the front, with the prospects of finding no employment and no income but a grant of 29s. from the Government, which will give very little comfort for those with wives and families. I am afraid there is going to be some very hard thinking among these returned soldiers of ours, after the fighting done and the sacrifices made to come back to the possibilities of starvation on 29s. at the present cost of living. Will they ask themselves the question, I wonder: Is this what we have fought for? Is this the thanks our country offers us after four years of hell?

The present position is very serious; let us face it boldly, reasonably and together, and above all justly; we are entering into new conditions; history is being made; the old world will never be quite the same to us, but I am sure with justice, reason and mercy this old British race of ours will once more rise to the occasion to place us in that position which, after the last four years or more of horror, we may justly claim.

Yours faithfully,

Birmingham. W. J. MACLACHLAN.

TO THE EDITOR OF ENGINEERING.

SIR,—During my service overseas as an officer in charge of a forward travelling gun-repairing workshop, I have come into closer touch with the skilled workman than is perhaps possible under any other conditions, for one shares all their trials and troubles, and thus it is possible to get under the "trade union" feeling of suspicion.

I have had some hundreds of men of most of the skilled trades under me, and have kept a rough diary of the opinions they have of trades unions in general, and they all agree that a good man is prevented to a great extent from doing well for himself, owing to the standardisation of wages, for the good man has to carry the medium and poor worker with him. I would like to suggest the following, which I have at various times, when opportunity presented itself, discussed with men, and without exception they are all in favour of its adoption:—

That every tradesman carries a card, which card gives details of the owner's efficiency, this is arrived at by an examination held, with, as examiners, a representative of the Employers' Federation (works manager) and a trade union official, who must be in both cases practical men. The results of such examinations will be detailed upon the owner's card as "excellent," "good," or "fair," for "heavy," "medium" or "light" work. There would be three rates of wages possible, one for each class, and at the end of twelve months a man could demand re-examination with a view to betterment.

I subjoin herewith a rough idea of such a card, which could be made up something like the soldier's pay book, and it would then act as a pocket case as well, and therefore would not be so liable to loss.

Name..... Address.....

Registered Number..... Member of ..... Union.

Trade.	Heavy.			Medium.			Light.		
Turner:—	Excellent.	Good.	Fair.	Excellent.	Good.	Fair.	Excellent.	Good.	Fair.
Brass									
Tin									
Iron									
Copper									
Fitter									
Tool Maker ...									
Jig Maker ...									
Press Operator ...									
Auto Machine Setter ...									
Auto Machine Operator ...									
Smiths' Work ...									
Moulder									
Pattern Maker ...									
Joiner									

Etc., etc.

Signed by..... for Employers' Federation.

Signed by..... for .....Trade Union.

Date.....

I put these suggestions forward, not as an expert, but as one who has pre-war employed such men, and therefore as one who is directly interested, and also who desires to see all these labour disputes a thing of the past.

Yours truly,

FAVILLE C. POULTON,
Lieutenant (late Acting-Captain) I.O.M., A.M.I.E.E.

Forthside, Stirling, N.B., February 12, 1919.

"NEW INDUSTRIES FOR ENGINEERS."

TO THE EDITOR OF ENGINEERING.

SIR,—Your allusion to "the large and prosperous engineering undertakings in Switzerland" in to-day's issue of your Journal reminds me that Switzerland had means of educating engineers long before we took the matter up in this country. Switzerland, "a country practically devoid of coal and iron," was full of highly-trained engineers, many of whom ousted Englishmen (whose names I can give to you) fifty or sixty years ago from leading positions in foreign countries; and the daughter of my old friend Buticaz was the first woman to take an engineering degree; so the existence of Swiss engineering works is no mystery. Did you, Sir, know that the son of one of our cleverest English scientists is now in Switzerland absorbing what it would be difficult, if not impossible, for him to find in England.

I have an inconvenient memory for some things, and I fear that you are putting too much blame on Mr. Chamberlain's Acts of Parliament which, thirty-five years ago, put an end to much gambling and wild speculation; and the reaction may have carried municipal things a little too far; but do not allow this to be made an excuse for our shortcomings in regard to knowledge. "Legislative drawbacks" may sound better than the real reason for our being left behind in so many races; but let us look at all the facts and try to get ahead again.

Faithfully yours,

WILLIAM H. MASSEY.

Tonyford, February 15, 1919.

THE BRITISH JOURNAL PHOTOGRAPHIC ALMANACK.—Although of less formidable dimensions than in past years, this volume comes to hand with the quality of its contents kept up to the usual high standard. The foremost place is taken by a most useful chapter on Photographic Definitions covering the whole field of the science, whilst notes on apparatus, processes and formulæ are numerous and excellent. One feature, symptomatic of the difficulties which manufacturers have to contend with at the present time, is the almost general absence of price quotations for the various commodities mentioned in its many advertisement pages.

TRADE WITH THE DOMINIONS.—The Federation of British Industries has had under consideration the means by which it could contribute to developing the commercial ties between Great Britain and the Dominions and with this object in view has organised, with the support of the various Dominion representatives in London, a series of tours of members of the various Dominion Imperial Forces to the industrial centres of Great Britain. The first of these tours started on the 18th inst., when a representative party from the South African Imperial Force was entertained by the federation at the Princes' Restaurant, and left later in the day for Grantham. During their tour the South African representatives will have the opportunity of visiting the firms of Ruston and Hornsby, Limited; the Birmingham Railway, Carriage and Wagon Company, Limited; the General Electric Company, Limited, at Witton; the Wolseley Motor Company, Limited; and the Handley Page aeroplane works. It is hoped that as a result of these tours the South African representatives will obtain a useful insight into the productive power of the Mother Country, and will enter into personal relations with our leading manufacturers to the mutual benefit of South Africa and Great Britain. The federation considers that these tours, besides being of commercial importance, may serve as some small mark of the appreciation which is felt by British industry of the magnificent achievement of the Dominions during the war, and may in some small measure contribute to consolidate the ties of friendship which have grown out of the sufferings borne in common during the last four years.

AUTOMATIC COPPERPLATING.—Owing to the high melting-point of copper, and to the oxidisability of copper and iron, attempts made to plate iron with copper by immersing the sheets into molten copper have so far failed. According to Professor J. W. Richards (Bulletin of the American Institute of Mining Engineers, January, 1919), the Metals Plating Company, of Elizabeth, New Jersey, have adopted a new process of what they style automatic copperplating; the process is covered by American patents of the year 1916, granted to William E. Watkins. The principle of the process is that a mixture of copper oxide and reducing agents is applied to the sheet iron in the form of a fairly fluid paste by an inking machine; the sheets are then passed through a furnace in which a temperature is maintained sufficiently high to reduce the copper and to weld it with the iron. The best plating mixture consists of 4 lb. of copper oxide and the same amount of finely-divided metallic copper ground up in 1 gallon of Mexican crude oil of 14 deg. or 16 deg. Baumé; this oil is asphaltic and seems to be the cheapest reducing medium available. As 1 gallon of this oil is said to be able to reduce 5 lb. of copper oxide, part of the oil would remain at disposal for reducing any iron oxide formed during the operations. As described the sheets are singly inked by the machine and either lifted up by hand or automatically fed into the machine by a device due to Mr. Conran, of the same company. In this device the sheets are stacked on the top of one another and the pile is continually being raised so that the top sheet is always at the same level; a suction cup above the pile further raises the top sheet, while a jet of compressed air is introduced beneath the sheet to prevent its adhesion to the sheet below. The inked sheets are fed on a conveyor and there compressed laterally so as to be bent to a cylindrical arch with the inked face upward; in this shape they enter the furnace, being better suited to withstand collapse than when flat. The parts of the conveyor exposed to the full heat are made of nichrome. The furnace atmosphere is reducing; the carrier delivers the sheets to flattening rolls which pass them on to the cooling room. There are a few illustrations in the article, but hardly any further particulars.

THE GERMAN IRON INDUSTRY INTERESTS IN LORRAINE.

A NUMBER of the leading German concerns in the iron industry, more especially those in the Saarbrücken district, are very heavily interested in Lorraine undertakings, none more so probably than the firm of Thyssen and Co., Mülheim-an-der-Ruhr, which early in the present century commenced acquiring iron ore deposits in Lorraine on both sides of the frontier, then, and up till now, in existence, and also secured a substantial share in the Sambre et Moselle (Montigny and Mézieres) iron works. Thyssen, in addition to Hugo Stinnes, is also the principal shareholder in the coal-mining concern, the Saar and Mosel Mining Company, Karlingen, Lorraine. In the year 1912 the Thyssen firm, through purchase of shares secured a controlling influence in the Lorraine Iron Works. The area of the minette concessions, in German and French Lorraine, of which the Thyssen firm, by a series of purchases, has acquired the control, amounts to about 15,000 acres. The extensive works at Hagendingen, comprising iron works, Thomas steel works and rolling mills, were only taken in hand in 1910, within comparatively few years of the commencement of the war, and the following year they were transferred into a separate company, the Thyssen Steel Works, with the altogether nominal capital of 1,000,000 marks, but with the unlimited Thyssen credit at its back. At the end of 1917 the iron works and the mines stood booked at 83,610,000 marks, the company's liabilities to the so-called Thyssen group amounting to 54,830,000 marks. The company has only once paid a dividend, of 4 per cent., in the year 1913, but Thyssen has his own way of managing and financing his immense industrial property. The report that Thyssen had sold his property in Lorraine to French buyers has been contradicted, and Germany will, one may rest assured, do all in her power, whatever that may amount to, to prevent the privately-owned German industrial undertakings in Lorraine from being transferred to French owners. At the worst, payment at their full value is hoped for.

Of other large German concerns materially interested in Lorraine may be mentioned the Dillingen, the Röchling and the Stumm undertakings, which all own blast furnaces in Lorraine, and the Gelsenkirchen and the Rombach concerns, to mention two more, are also heavily engaged in the Lorraine industry. Under the present circumstances the Lorraine iron works are naturally placed in an awkward position; they are only working on a reduced scale, they have to pay their men in francs they cannot, at least not at their own will, handle or dispose of their production and their connection with the Steel Union has, of a necessity, been upset. France is understood to have already helped them with an advance, but otherwise they have to fall back upon their German connections.

It goes without saying, that the iron and other industries of Lorraine have been vastly developed during the fifty years which have passed since the previous peace, and the introduction of the Thomas method (1878) gave a mighty impetus to it. A few figures to show the present extent of the iron and other kindred industries in Lorraine may be of interest:—

In the year 1912 there were in Alsace-Lorraine, 101 limited companies with a capital of 486,000,000 marks and reserves of 132,000,000 marks. Of these, 132 companies, with a capital of 363,000,000 marks, paid dividends averaging 8·2 per cent. They were mostly mining companies and iron works, alkali undertakings and textile companies.

In the year 1912, there were in Alsace-Lorraine: 2,270 sq. km. of rented ore deposits; 70 sq. km. exploited in mining; 3,539,000 tons of coal, representing a value of 38,900,000 marks, were worked; 47,176 tons of petroleum, representing a value of 2,800,000 marks, were produced; 20,080,000 tons of iron ore, representing a value of 53,930,000 marks, were worked; 9,758,000 tons of iron ore were used at the iron works (in 1911); 2,908,000 tons of pig-iron, representing a value of 136,210,000 marks, were produced; 1,444,950 tons of steel were produced, representing a value of 154,380,000 marks; 2,457,000 tons of coal were imported; 137,240 tons of alkali, representing a value of 2,960,000 marks, were produced; 72,543 tons of salt, representing a value of 1,518,000 marks, were produced. The State railways had an aggregate length of 1,921 km.

SHIPBUILDING IN JAPAN.—A notable feat recently accomplished in Japan is the building of a steel steamer of 5,800 tons gross, and 9,000 tons deadweight, within 24 days, says *The London and China Telegraph*. The keel of the steamer, the Raifuku Maru, was laid down at 7 a.m. on October 7 last; the vessel was launched at 6 a.m., on October 30, the official trials were successfully carried out on November 5, and within a few days she sailed, laden, for South America. The length of the vessel is 385 ft.; her beam is 51 ft., and her moulded depth is 28 ft. She attained a mean speed of 14·39 knots on the two trial runs of 3 miles each. The whole of the construction was carried out under the survey of "Lloyd's Register." This feat of rapid construction is clearly an important and creditable incident in the development of the Japanese shipbuilding industry, for the short time taken represents a very remarkable reduction on the period hitherto required. Even in the United States, where, last year, feats of rapid construction quickly succeeded each other, great prominence was given to the building of the steamer Crawl Keys, at Ecorse Detroit River, within 29 days. Yet the Crawl Keys was a much smaller steamer than the Raifuku Maru, being 2,300 tons gross, and 3,300 tons deadweight, with a length of 261 ft. 6 in overall, a beam of 43 ft. 6 in., and a depth of 22 ft. 6 in. The Raifuku Maru was built on the gantry system by the Kawasaki Dockyard Company, Limited, at Kobé.

MASK AND BODY PROTECTOR FOR WELDERS.

We illustrate on the present page a pattern of mask and body protector for welders, which is now in extensive use at the works of Messrs. Cammell Laird and Co., Limited, at Birkenhead. It is very essential that an appliance of this kind should be so made that the wearer has the free use of his hands even when in awkward positions, and this requirement is well met by the device shown. The mask is attached to the wearer's head, while the fireproof protecting cloth is fixed to his overalls and can be raised or lowered as required to permit the worker to see or speak. The ear-pieces can be opened or closed as desired and the eye screen can be lowered as shown in one of the illustrations.

If necessary—as, for instance, when arc welding is being done overhead—a fireproof cloth cap can be added to the equipment. The patent rights for the arrangements illustrated are held by Messrs. Cammell Laird and Co., Limited, and Mr. E. V. Jones, the assistant shipbuilding manager at the works at Birkenhead. It may be added that the equipment affords good protection for men working side by side at a bench, a condition of affairs when, if hand screens be used, trouble is caused to a worker by the flashes of other electrodes than his own.

PATENT LITIGATION IN 1918.

A number of cases of patents tested in the Courts, of interest to engineers, have been reported in 1918.

Among these, Ferranti's Patent No. 18047/03, relating to spinning, twisting and doubling machinery, was held to be very meritorious, and its non-user satisfactorily explained, so that an extension of the patent for seven years was granted, as to some of the claims.

Worrall's Patent No. 13100/04, for fences comprising bars with a series of punctures therein, combined with bars passing through the punctures was sought to be extended, but the petition was dismissed on the ground that there was no novelty in the invention.

Dewar's Patent No. 13638/04 for the absorption of gases by exposing to the gas charcoal cooled to a temperature comparable with that at which the gas to be absorbed boils, was held to be very useful and the remuneration of the patentee to have been inadequate. An extension of the patent term for five years was therefore granted.

Taylor's Patent No. 12735/04, for a short base rangefinder, was also extended for five years, the comptroller not contesting the merit of the invention or the inadequacy of the patentee's remuneration, but certain conditions were imposed as to the supply of rangefinders to Government departments.

Action was brought on a patent to Just, No. 8743/03, for drying and preserving milk and milk-like products, according to which it was alleged the solids of the milk were obtained in a dry, but otherwise unaltered condition. At the trial it was held that this claim could not be substantiated, and the patent was declared invalid. This finding was upheld by the Court of Appeal.

The Stahlwerk Becker Patent No. 27838/12, for a high-speed tool steel produced by the addition of up to 15 per cent. of cobalt in chromium or tungsten steels, was revoked on the ground that steel made according to the prescription in the specification and sold prior to the date of the patent was not experimental, nor was the manufacture of it secret or confidential. This decision was upheld by the Court of Appeal and subsequently by the House of Lords.

Revocation was also ordered of the Daimler Patent No. 16924/13, for steel cylinders for internal-combustion engines made in one piece with lugs, flanges and the like, having the cooling jacket welded to the lugs and flanges on the cylinder, upon which latter no direct welding takes place.

Action was brought on the patent to Justice, No. 4236/07, for a pulling-over machine for boot and shoe manufacturing, in which the last was supported bottom down in a plane at an angle to the horizontal, with the toe pointing upwardly toward the rear of the machine, and with the fore part and tip line in full view of the operator. It was held at the trial that the position of the boot in the patented machine was the position in which the hand-laster views his work in order to see whether the tip line is correct, and that while it was true that the machine produced better results both in speed and quality than a prior machine, which was alleged to be an anticipation, there was no invention in the idea. The action was therefore dismissed, and the judgment upheld subsequently both in the Court of Appeal and in the House of Lords.

Another important case is that of the B.T.H. Patent No. 21513/06, for working tungsten by subjecting the metal in a coherent form to the action of heat, while it is being operated on or manipulated. It was held by the Court that a wide claim for so working tungsten could not be upheld in view of the state of the art, and the common practice of metallurgists. The patent was therefore declared invalid, and this judgment was subsequently upheld by the Court of Appeal and the House of Lords.

There were no design litigation cases in 1918, of special interest in engineering, but three trade-mark actions should be noted.

An application practically for the registration of the word "Victory" as a trade mark for hack saws was opposed by owners of the trade mark "Victor" with a laurel wreath. It was held that the applicants user was modern and with a knowledge of the owners' rights. Registration was, therefore, not allowed.

A special application for the registration of the surname "Lodge" in respect of sparking plugs, was allowed to proceed, the name, although not particularly rare, not being a common one, and the user as a trade mark for ten years being established.

In an action brought by the A.G.S. Manufacturing Company, Limited, the defendants, who alleged that the letters "A.G.S." were used in the trade to denote aeroplane parts in a general schedule, were restrained from representing that they stood for the name of the defendant company in any way. This was upheld on appeal.

MASK AND BODY PROTECTOR FOR WELDERS.

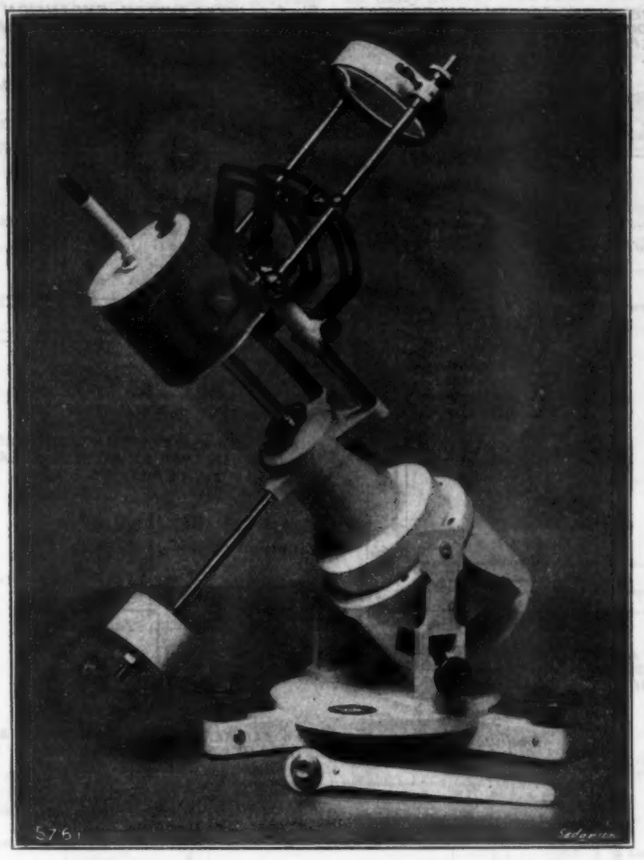
The German Locomotive and Rolling-Stock Industry.—The same unsatisfactory, retrogressive conditions which at present prevail in most German industries manifest themselves in locomotive and wagon construction. The main and auxiliary workshops of the Prusso-Hessian railways employed before the war 70,300 hands, which number gradually was doubled during the war, amounting in the beginning of 1918 to 140,140 hands. In spite of this increase in the number of employees, the capacity of the works has materially decreased. It is stated that during the summer of 1918 as many as 950 locomotives were delivered duly repaired per week, whilst the number had receded to 680 per week in the beginning of 1919. The shortage of materials is not so pronounced at these works as at the private concerns, since the Railway Department still has considerable stocks. The lack of copper caused much difficulty during the war in the repair of locomotives, and certain parts which were formerly always made of copper had to be made of iron. Demobilisation has, to a great extent, mended matters and, besides, a fair amount of copper is said now to be available. The private concerns have had greatly to reduce their output. One of the largest undertakings in this branch in North Germany was not able to deliver a single locomotive during December, although the number of hands employed had been materially increased. A number of new firms have taken up the repair of locomotives, but seem to have to contend against a considerable amount of technical difficulties. The Prussian Department for Public Works has placed contracts for an amount of 1,600,000,000 marks, and altogether 3,300 locomotives and 71,000 wagons have been ordered. The Berlin Tramways have recently contracted for a large number of cars and trailers, principally with the Hannover Wagon Company which, being outside the combine, accepts lower prices than the works within the ring. These works have orders for 100 driving cars and 100 trailers, the former being about 250 per cent. and the latter 100 per cent. dearer than before the war.

The Industrial Reconstruction Council.—A special conference will be held under the auspices of the Industrial Reconstruction Council, on Thursday, February 27, at 5.15 p.m., in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C. 4, when an address will be given by Major Pells, R.E. (Assistant Director, Efficiency and Costs Section, Ministry of Munitions), on "Scientific Management in Industry." The lecture will be followed by a discussion. No tickets are necessary.

The Clyde-Built Airship R. 34.—The new Clyde-built airship R. 34, says *The Glasgow Herald*, is expected to have a speed of 80 m.p.h. to 90 m.p.h. under average weather conditions, and to be capable of crossing the Atlantic from Scotland to New York and returning without stopping. She is 670 ft. in length, 79 ft. in diameter, and of 2,000,000 cub. ft. capacity. She has a lifting power of 50 tons, and a total horse-power—in five engines—of 1,250. Four cars or gondolas are suspended from the framework, the forward being the navigating or control car from which the vessel is operated, and in which there are also the wireless telegraphy and wireless telephony cabin and the ballast and bomb controls. From each car there runs to the top of the vessel a wire ladder, which leads also into a corridor that runs all the length of the ship. At the extreme stern, near the rudder and the elevating planes, there is a machine-gun platform, while right on the top there is another platform for machine guns and also for a 2-pounder gun. There are water ballast tanks having a capacity of 2,000 lb., and petrol tanks capable of carrying fuel sufficient for eight days' continuous running. All these tanks can, if necessary, be released at any time and dropped clear of the ship. If caught at sea in fog the R. 34 can stay in the air for three weeks at a time, or can throw out a sea anchor and ride out a storm, keeping in touch with the land by wireless, or asking for whatever assistance may be desired.

Personal.—The Dominion Iron and Steel Company, Limited, of Sydney, Cape Breton, Canada, inform us that they have appointed Mr. John McSkimming, of Atlantic Chambers, 45, Hope-street, Glasgow, their representative in Scotland.—Messrs. Samuel Denison and Son, Limited, of Leeds, have opened a London office at 28, Victoria-street, Westminster, S.W. 1.—Mr. Thomas Clarkson, M.Inst.C.E., M.I.Mech.E., of Chelmsford, has been elected president of the Institution of Automobile Engineers for the ensuing year.—The Westminster Tool and Electric Company, of Suffolk House, Laurence Pountney Hill, London, E.C. 4, inform us that they have opened an office at 72, Waterloo-street, Glasgow.—Mr. J. E. Hurst has resigned his position as chief Metallurgical chemist to Messrs. D. Napier and Sons, aeroplane and motor manufacturers, of Acton, London, to take up the position of research chemist and technical adviser to Messrs. the Stokes Castings, Limited, chiefly engaged in the production of high-class castings by a patented centrifugal process.—We are informed that Sakchi, the site of the Tata Iron and Steel Works, has been renamed Jamshedpur by the Government of India, in commemoration of the founder, Mr. Jamsetji N. Tata. The postal address will be, in future: The Tata Iron and Steel Works, Jamshedpur, Via. Kalimati, B.N.Ry., India.—The Westminster Tool and Electric Company, of Suffolk House, Laurence Pountney Hill, London, E.C. 4, inform us that they have opened branch offices at 72, Waterloo-street, Glasgow, where stocks of their "Westpool" electric portable drills will be held.—The Hoyt Metal Company of Great Britain, Limited, have removed to 105, Deodar-road, Putney, London, S.W. 15.

MAURER'S HELIO-CHRONOGRAPH.



THE precision-heliograph, or sunshine-recorder which we illustrate in the annexed photograph, is due to Dr. Julius Maurer, director of the Swiss Federal Meteorological Institute at Zürich. The instrument is so mounted on its base that the axis can be fixed parallel to the earth axis; an adjustment for different latitudes can easily be made. The clockwork which is enclosed in the body of the instrument then turns the inclined axis in such a way that the lens mounted approximately at right angles to the axis, in a plane parallel to that axis, follows the sun in its apparent diurnal movement. The position of the lens is also adjustable; it can slide on the two supporting rods, which are themselves pivoted at their lower ends, and this movement is guided by the two arc-shaped projections shown in the photograph. With the aid of these devices it is arranged that the focus of the lens, which faces the sun, always falls on the cylindrical surface of the recorder drum which describes one revolution about its axis in the space of 2 hours; a worm gearing further imparts an axial movement to the drum, amounting to 6 mm. in 2 hours. The movement of any point on the drum is thus helicoidal, and the instrument can be adjusted for solar declination. The drum is covered with ordinary blue paper, into which the sun rays burn their record; the abscissæ indicate time. The lateral displacement of the card amounts to 120 mm. per hour; every point of the card is thus exposed to the sun rays for about ¼ minute, and a shadow period of ¼ minute is recorded by the heliograph; ordinary paper can be used, and the colour, hardness and thickness of the paper are matters of little consequence. In these respects, as well as in its essential features, the Maurer heliograph, which was first described in 1911 and has since 1913 been adopted in Switzerland and elsewhere, differs from that of Dr. Dupaigne, who last year claimed priority for his instrument of 1914. Dupaigne uses photographic paper, and his lateral displacement is only 14 mm. per hour. The Maurer helio-chronograph is made by the firm of James Jacquet, Bâle. The instrument is simple in spite of the advantages which it possesses over other heliographs. The large dimensions of the card are an important feature. Crowded records are not only indistinct, but where the burns are too close to one another, they immerge into one another.

APPRENTICESHIP INTERRUPTED BY WAR SERVICE.*

1. THE PROBLEM STATED.

THE problem may be briefly stated. Apprentices, who enlisted at 18, have lost periods of training, which often amount to as much as three years and occasionally to more. Those who enlisted at a later age have lost shorter periods. Except, therefore, where they have been employed in technical units, they will return to industry with no greater skill and knowledge than when they enlisted; and many of them will have forgotten much of what they had learnt. But they will return with the needs of men, and often of married men. If, therefore, they are to complete their training, they will require, while doing so, first, a man's wage and not a boy's, and, secondly, one equal or nearly equal to what they could obtain on unskilled or semi-skilled work.

On the other hand, such wages will be more than the employer can afford. In technical skill his apprentices will at best be in the position of youths of 18 or 19. It is true that, being older and in many cases improved in health, physique and self-reliance, their value will be greater than when they enlisted; but this will not compensate the employer for the increased wages he must pay to attract them back

Hence the gap, between what the employer can pay and the apprentice take, must be bridged if the apprentices are to complete their training and become skilled and not semi-skilled workmen. Their further training is rendered essential for industry by the depletion of skilled labour during the war, the more so that, being already half trained, they can be fitted most rapidly to make good the loss.

If a solution fair to both sides is to be found, the State must step in. It called upon the apprentice to abandon his training, the employer to release him; and it must therefore bear part of the cost of re-establishing him. The inquiries that have been made demonstrate, first, that the employer can and will pay a substantially increased wage during whatever further period of training is required, and that, by means of an intensive course of instruction, this period can be shortened. The obligations of the State, therefore, will be correspondingly reduced. It is proposed to meet them in the manner described below.

2. SCOPE AND OBJECTS OF THE SCHEME.

(i) The scheme is limited to those who, before enlistment, were apprentices in a skilled trade, and covers women as well as men. The numbers of women affected, however, should be very small.

(ii) Skilled trades are understood to be those in which, before the war, the normal practice was to require a person, as a condition of admission as a journeyman, to undergo a course of training of not less than three years' duration, for a period definitely fixed in advance, and terminating not earlier than the commencement of the twentieth year of age. This will be the minimum required of a trade as a whole, but individual employers must also comply with the provisions of the scheme appropriate to their particular business.

(iii) The term "apprentice" is used in a broad sense, and is not limited to those who are serving under an indenture or other written agreement. The test is rather that a person before enlistment was actually learning a skilled trade. Apprenticeship will thus include training given under less formal conditions, or where there is only a tacit understanding between the parties. Further, a person who was learning his trade in a number of firms may be allowed to qualify on the production of satisfactory evidence that he was actually being trained.

(iv) Training in a trade will be given under a definite scheme for each trade prepared by a body representative of employers and workmen in the trade and approved by the Minister of Labour. No State grant will be paid unless there is such a scheme, nor to any employer except in accordance with its conditions. The machinery to be adopted for preparing and enforcing such schemes is outlined below. It is proposed to utilise both the workshop and the technical institution in giving training.

(v) In every trade the scheme lays it down that apprentices over 21 (in Scotland 23) shall receive from all sources not less than certain fixed proportions of the journeyman's wage in the trade and district. This proportion will be three-quarters of the standard rate plus war bonus, (if any) for the first year of such training, and five-sixths for the remainder of it.

3. OUTLINES OF THE SCHEME.

1. *Apprentices Included and Excluded.*

The following conditions are laid down:—

(i) The apprentice must prove that he (or she) was, prior to enlistment, an apprentice as defined.

(ii) The apprentice must have been under the age of 21 (in Scotland 23) at the time of enlistment.

(iii) No State "allowance" will be paid in respect of any apprentice until the termination of his original apprenticeship, or until he reaches the age of 21 (in Scotland 23) where the apprenticeship continues beyond these ages.

(iv) No apprentice who was in his last year of service when he enlisted will be eligible for grant in respect of training in an employer's establishment unless, for special reasons, the Minister of Labour otherwise determines.

2. *Allowances Payable by the State.*

The following allowances may be paid subject to the conditions outlined below:—

(i) A "wage allowance" to apprentices receiving training in the workshop, at the rate of one-sixth of the standard journeyman's rate, including war bonus (if any), throughout the period of training. This allowance is payable for a maximum of 104 weeks.

(ii) A "maintenance allowance" to apprentices receiving training in a technical institution or training centre. Where whole-time training is given, the allowance shall be at the same rate as that payable to disabled men undergoing training for a trade, as provided under Article 6 of the Royal Warrant of March, 1917, or any modification thereof. Where the apprentice receives part-time training, the allowance shall be in proportion to the number of hours spent in such training. The full-time maintenance allowance shall not be paid for more than 40 weeks, and the part-time for more than an equivalent of 40 weeks whole-time training.

(iii) A "fees allowance" to cover fees paid by an apprentice receiving technical training, the amount payable to be determined by the Minister of Labour.

3. *Wages Payable by the Employer.*

To those returning under 21 (in Scotland 23) and having part of their original apprenticeship still to serve the employer shall pay the current rate of wages paid at the time to other apprentices of the same age in the same trade and district, until they reach the age or the termination of their apprenticeship, whichever come first.

The wages payable to other apprentices shall be those laid down in the scheme applicable to the particular trade. But in every case the wage shall be not less than seven-twelfths of the standard journeyman's rate plus war bonus for the district during the first year of training and eight-twelfths (two thirds) for the last year.

4. *Other Conditions of State Assistance.*

No grant shall be paid:—

(i) Unless the period of training lost by service in the forces is reduced by at least one-third. The exact amount of the reduction in a particular trade shall be laid down in the scheme applicable to it;

(ii) Unless the period is correspondingly reduced when the apprentice, while with the forces, has worked at his trade in a technical unit; and

(iii) Unless the employer and apprentice enter into an agreement, in such form as may be provided in the scheme for their trade, to complete the training in accordance with that scheme.

5. *Machinery for Drawing up Schemes.*

Where a National Joint Industrial Council or Interim Industrial Reconstruction Committee exists, it will be entrusted with the task of drawing up a scheme for its trade or industry. Failing this, the task will be com-

* Statement issued by the Press Bureau.

ELECTRIC WELDING IN THE CONSTRUCTION OF STEEL VESSELS.

Fig. 1. MIDSHIP SECTION OF ARC-WELDED BARGE. LENGTH, 125'-9" BREADTH 16'-4" DEPTH MOULDED, 7'-9" DEADWEIGHT CAPACITY, 200 TONS. FRAMES, 2½"×2½"×¼" ANGLES. FLOORS, 7"×3½"×⅜" ANGLES. SHELL & DECK PLATING, ⅝" TO ⅜". SHELL PLATING JOGGLED & LAPPED AT EDGES, FLUSH BUTTS WITH STRAPS. DECK PLATING STRAPPED BUTTS.

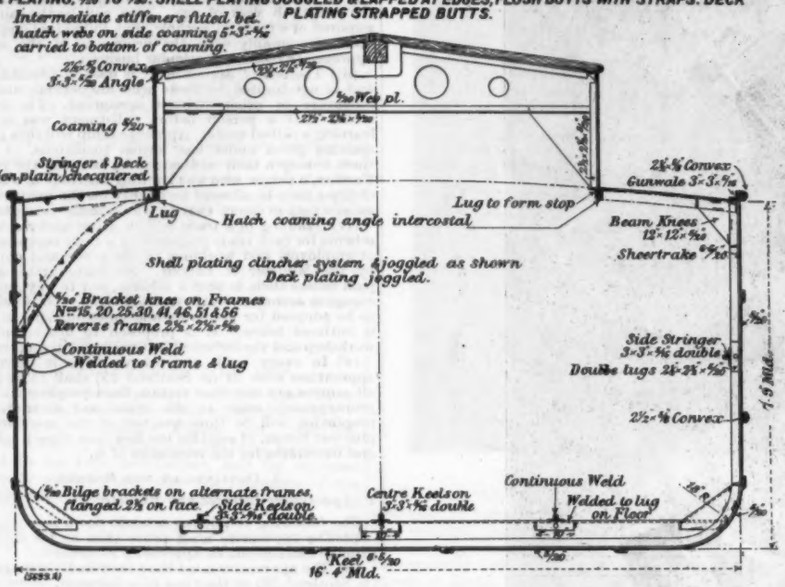

Intermediate stiffeners fitted bet. hatch webs on side coaming 5"×3"×⅜ carried to bottom of coaming.
2½"×⅜ Convex
3"×3"×⅜ Angle
Coaming ⅜
Stringer & Deck ⅜ (en plain/chequered
Lug
Hatch coaming angle intercostal
Lug to form stop
2½"×⅜ Convex Gunwale 3"×3"×⅜
Beam Knees 12"×12"×⅜
Sheertrake ⅜
Shell plating clinker system & joggled as shown
Deck plating joggled.
⅜ Bracket knee on Frames Nos 15, 20, 25, 30, 41, 46, 51 & 56
Reverse frame 2½"×2½"×⅜
Continuous Weld
Welded to frame & lug
Side Stringer 3"×3"×⅜ double
Double lugs 2½"×2½"×⅜
2½"×⅜ Convex
⅜ Bilge brackets on alternate frames, flanged 2½ on face
Side Keels on 3"×3"×⅜ double
Centre Keels on 3"×3"×⅜ double
Continuous Weld
Welded to lug on Floor
Keel, 6"×⅜
16'-4" Mld.
7'-9" Mld.

Fig. 2. CLINKER SYSTEM—SECTION SHOWING WELDED SHELL PLATING.

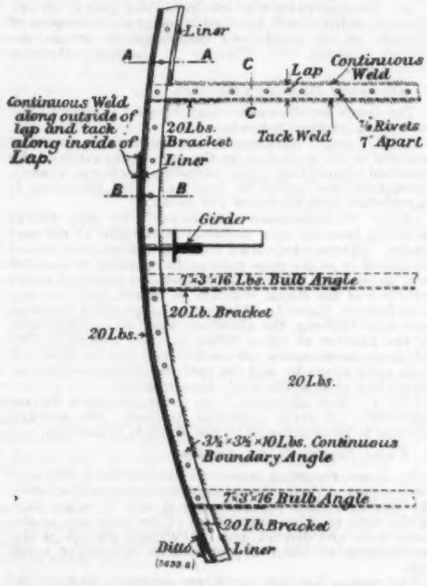


Fig. 3. RAISED AND SUNKEN SYSTEM & CONTINUOUS WELDS. TRANSVERSE ELEVATION SHOWING SHELL & W.T. BULKHEAD PLATING & THEIR CONNECTIONS.

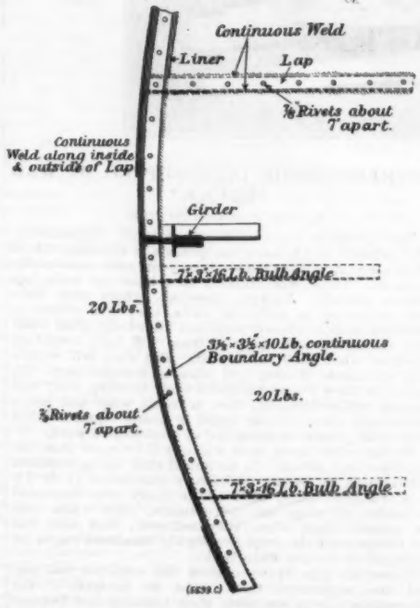


Fig. 4. CLINKER SYSTEM—EXPANSION OF SHELL PLATING SHOWING LAPS & BUTTS.

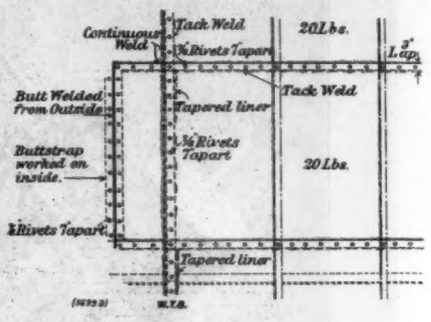


Fig. 5. CLINKER SYSTEM—SECTION AT C–C SHOWING METHOD OF WELDING AT LAP OF BULK'd PLATING.

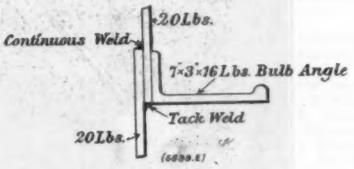


Fig. 6. CLINKER SYSTEM—SECTION AT B–B SHOWING METHOD OF WELDING TAPERED LINER AT LAP OF SHELL PLATING.

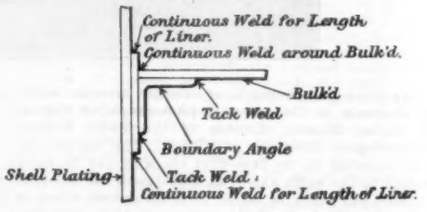
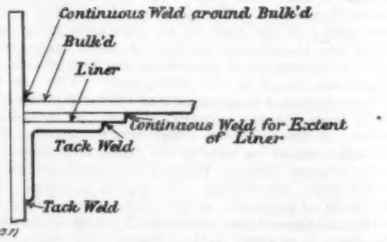


Fig. 7. CLINKER SYSTEM—SECTION AT A-A SHOWING METHOD OF WELDING TAPERED LINER AT LAP OF BULK'd.



mitted to any other body which in the opinion of the Minister is sufficiently representative of employers and workmen in the trade. Where no such body exists, the Minister himself may prepare a scheme.

No such scheme shall have effect until approved by the Minister of Labour, and, in respect of any provision or technical training, by the Board of Education.

In addition to matters already referred to, these schemes will deal with such subjects as :—

(i) The trades to be covered and the provisions required for particular trades.

(ii) The amount and character of the technical training to be given.

(iii) Any special provisions, as, for instance, for apprentices who enlisted during the last year of service.

6. *Powers of the Minister of Labour.*

The following powers are entrusted to the Minister of Labour :—

(i) To make such rules as may be necessary for the administration of the scheme and to provide for the manner in which application for, and payment of, allowances are to be made.

(ii) To take whatever steps are necessary to secure the proper observance of the schemes of training drawn up for different trades.

(iii) To discontinue or reduce an allowance in cases in which the training given to an apprentice, or the industry and conduct of the apprentice himself, are not of a satisfactory nature.

(iv) To decide disputed questions as to the right of an applicant to an allowance.

In regard to the last point, it should be noted that no applicant has any absolute right to an allowance under the scheme, and that the Minister's decision on disputed points shall be final.

A COMPARISON BETWEEN AMERICAN AND BRITISH PRACTICE IN ELECTRIC WELDING.*

By Commander S. V. Goodall, Naval Constructor, British Navy.

With respect to their attitude towards electric welding the various practical shipbuilders in America and Great Britain may be divided, roughly, into three classes.

First : The very few who speak as though a riveted joint were the most sacred and efficient institution ever conferred by Divine providence upon unworthy man.

Second : The very few (personally, the writer has not met a single one) who speak and dream of rivetless ships and noiseless shipyards, peopled largely by women.

Finally, there is the great majority of shipbuilders who are too busy to develop new, though promising, methods, but who will employ any new process as soon as they are convinced that this is worth doing. To these are commended the matter and spirit of this paper, and their attention called to the attitude of the British Admiralty, the United States Navy Department, Lloyd's and the American Bureau.

In October, 1917, not a very recent date, considering the rate at which scientific matters now progress, the British Admiralty called a conference of some of the most experienced constructors from various navy yards, and some of their recommendations were as follows :—

1. Although the covered electrode, or quasi-arc, process of electric welding could not be advantageously adopted in all cases as a substitute for the present

* Paper read before the Engineers' Club of Philadelphia.

process of drilling, riveting, caulking, &c., yet its use would undoubtedly result in a great reduction in the labour involved in such processes.

2. While it was not considered that any advantage would accrue from the application of this process to the present arrangements of riveted non-watertight laps, butts, stiffeners, &c., all watertight work of this nature could probably be well and efficiently performed with economy in labour, by increasing the rivet spacing as much as possible, consistent with the proper closing of the work, and supplementing this by covered electrode arc welding to meet the requirements for strength and watertightness.

3. By this system the process of water testing would be greatly facilitated, with a corresponding saving in time and labour.

The United States Navy Department, Lloyd's, and the American Bureau have sanctioned the use of electric welding for angle staples, plate staples, and similar watertight work, in addition to its general use on such

Fig. 8. RAISED & SUNKEN SYSTEM—EXPANSION OF SHELL PLATING SHOWING LAPS & BUTTS.

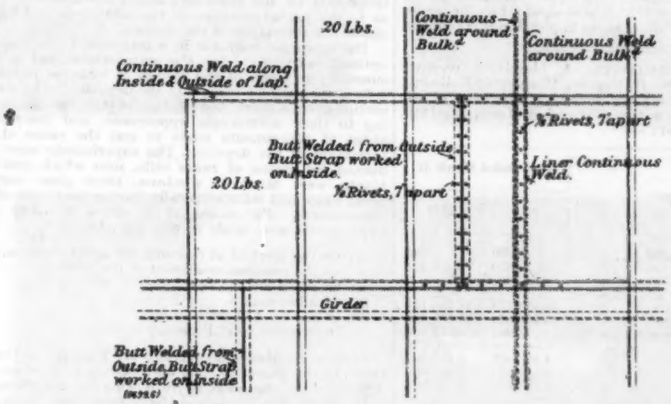

20 Lbs.
Continuous Weld around Bulk.
Continuous Weld around Bulk.
Continuous Weld along Inside & Outside of Lap.
⅝ Rivets, Tapart
Butt Welded from Outside Butt Strap worked on Inside.
Liner Continuous Weld.
20 Lbs.
⅝ Rivets, Tapart
Girder.
Butt Welded from Outside Butt Strap worked on Inside.

Fig. 9. RAISED & SUNKEN SYSTEM & CONTINUOUS WELDS—SECTION C–C SHOWING METHOD OF WELDING AT LAP OF BULKD PLATING.

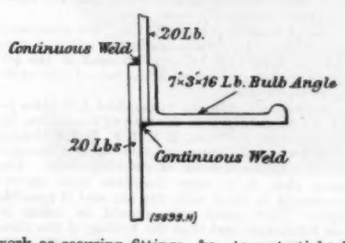
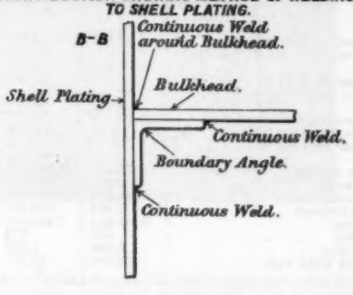


Fig. 10. RAISED & SUNKEN SYSTEM & CONTINUOUS WELDS. SECTION SHOWING METHOD OF WELDING BULKD TO SHELL PLATING.



work as securing fittings, &c., to watertight bulkheads and decks, whereby not only are time and labour saved, but better watertightness is obtained.

Passing now to specific examples of electric welding, we will first speak of the American practice. It will be quickly seen that American and British practice differ very considerably. In Great Britain the process invariably used is the quasi-arc, since British engineers have found the flux-covered electrode and this system the best they have so far tried. We have, however, an open mind and a desire to reduce costs, so that any other system will find a fair field and no favour.

American Welding Practice.

The following extracts from letters which the writer has received from some of the leading shipyards in America may be illustrative of the typical jobs to which electric welding is applied in the United States :—

Newport News.—We have been using electric welding for the past four years, and although it has been developed to quite an extent, we feel that much more work can be done by this method, as soon as the various inspectors realise the full value of electric welding and will allow its more extensive use.

"Referring to your request for facts relative to the saving of time, labour and money which have been effected by the adoption of electric welding : The developments in connection with electric welding have been so rapid and the uses to which it has been put have been so extensive that we have not attempted to obtain comparative costs between this and other methods, having contented ourselves with the very evident economy obtained by the electric method.

"We are not in sympathy with the completely welded ship idea, but believe there is a happy medium limiting the extent of the electric welding, which, to a great degree, is determined by the personnel of the welding department and the experience to those who outline the work to be done by the electric method."

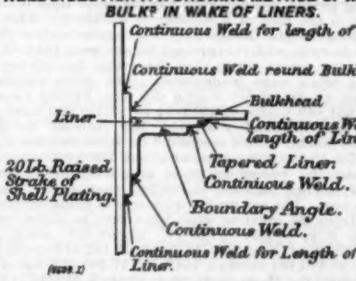
Bethlehem Shipbuilding Corporation.—"We are, in the yard, welding all the non-strength clips and fittings to the destroyers, such as furniture clips, cocoa-matting strips, backing strips for sheathing, shelf clips, &c. The welding of these small jobs eliminates the work of punching the clips, laying off for drilling, bolting up and finally riveting. This work, it will be noted, is very much scattered and therefore comes under the shipyard term of 'odd work.' Odd work is necessarily very costly.

"The above jobs are now being done at a very much reduced cost and very much less time. . . ."

The Panama Canal, Department of Operation and Maintenance.—"It may seem like a strange assertion to state that we do not employ anglesmiths in the shops, but we do not require them—all our angles are welded together by the oxy-acetylene and electric welding processes.

"Frames, staples, webs, brackets, sheet iron and steel boxes, leaky joints on ships' bottoms, plates of tanks, pipes and fractures in all kinds of ship machinery are welded ; in fact, electric welding, oxy-acetylene welding and cutting and oxy-hydrogen cutting are so extensively

Fig. 11. RAISED & SUNKEN SYSTEM & CONTINUOUS WELDS. SECTION A–A SHOWING METHOD OF WELDING BULKD IN WAKE OF LINERS.



used in ship work that they have become practically indispensable in their use to the Mechanical Division on account of the big saving in time, labour and cost.

"From our own experience and through keeping in touch with this line of work being carried on in the industrial establishments in the States and elsewhere, we have come to the conclusion that oxy-acetylene or electric arc and spot welding in their present stage of development cannot supplant all watertight ship work that is now being done by riveting, but it will be only a matter of time, due to the rapid strides made in the development of autogenous welding outfits, when all obstacles in this line of work will be overcome."

The Submarine Boat Corporation.—"We are welding approximately 60 frames on each ship in addition to doing a great deal of miscellaneous welding in connection with outfitting of ships. The welding in outfitting has not yet fully developed. By this, I mean that we are daily finding additional places where electric welding can be used to advantage, and we are strongly inclined to push the use of welding to the limit, for the reason that we find it considerably cheaper than angle-smithing work for frames, and considerably cheaper and faster than drilling and tapping deck beams and bulkheads for attaching miscellaneous small brackets."

In the first discussion of this series, the work being done at the Norfolk Navy Yard, where an electrically-welded battle-practice target is under construction, has been described by Naval Constructor H. G. Knox, U.S.N., and will not be taken up in detail in this paper. It may be well to note, however, that this structure is composed of simple plate work with no liners and no curved plates, and that while it is a good design to start on, it has, however, because of lack of curved surfaces, the disadvantage that it does not, in this particular, apply to the conditions existing in an ordinary ship—particularly to a merchant ship.

The joint between the flat keel and side keel plates and the joint for attaching plates at right angles appear to the writer to be amply strong and likely to remain watertight longer than a riveted joint. The welds, however, are heavy and, according to British experiments, they will be extremely costly, compared to riveting. Further, on account of inaccessibility, it would appear that good welding would be difficult to obtain.

On the other hand, this design will serve to demonstrate whether it is easier to work plates transversely or longitudinally, and whether the difficulties anticipated, from unusual shrinkage are the same in both cases. When complete, this structure will not be subjected to such a variety of complex live loads as a ship, but at various times in its career it will be subjected to considerable shock, so that valuable experience will be obtained.

Spot Welding.

Before leaving American practice, a few words should be said about spot welding. Professor Comfort Adams has given his opinion as follows :—

"Electric spot-welded joints, properly made, are stronger than riveted joints. The total labour required for the welding of a given number of spots is about one-quarter to one-fifth of that required for the same number of rivets.

"The only fear that has been expressed by anyone in connection with the application of spot welding to ship-building is that crystallisation may develop as a result of the ship's vibration. It is the opinion, however, of some very able shipbuilders that the intensity of the vibrational stress in the structure of the ship is not sufficient to warrant this fear. In any case, it is hoped to plan such vibrational tests, in connection with the work of this sub-committee, as to clear up this point.

"Everyone with whom I have talked on this subject agrees that the probable gain by the substitution of spot-welded for riveted joints in shipbuilding is so great as to warrant the expenditure of every effort to give it a thorough trial."

Shipbuilders in Great Britain would be very glad to profit from American experience. They certainly fear crystallisation, the possibility of a poor joint through some defect between the faying surfaces, and also that the joint may ultimately fail through one weld being poor or taking an undue share of the load.

British Welding Practice.

Passing now to British practice, and taking up first the question of repairs, the following typical instances are illustrative of the very broad field to which electric arc welding has been applied in Great Britain, with great savings in both time and expense.

In one case, a ship with a number of fractures in the bottom plating was repaired by welding up the cracks after they had been "veed." This work was accomplished in 16 hours, whereas the renewal of plating would have involved the loss of that ship's services for many days.

In another case, a steel stem casting, broken into five pieces by collision, was repaired in seven days. To obtain a new casting would have required four to five months.

In other cases, ships which were experiencing trouble through leaky butts straps were repaired by welding a thin strip over the joint and a satisfactory result obtained. To fit a double strap outside the ship (the practice before electric welding was introduced) would have involved much time and labour and would not have been very satisfactory, causing a poor surface and a poor joint.

The reinforcement of badly-pitted plates is another of the uses to which electric welding has been applied in ship repair during the present war.

Electrically Welded Barge.*

The construction of this ship (see Fig. 1, page 254) is similar to that of a riveted ship. The plates were bolted up when the parts were assembled, and after welding the bolts were removed and replaced by plugs, which were welded up flush with the plating.

The plates, &c., are comparatively light and easy to weld, the only difficulty in the thin plates being that the plate may be grooved along the weld if the operator is not particularly careful.

The type of joint used in this construction was chosen with the purpose of making as much as possible of the welding horizontal, so as to render good work more easily obtainable.

Experiments Designed to Show the Relative Merits of Welded and Riveted Ship Construction.

We now come to two of the most interesting applica-

* For particulars relative to this work the writer is indebted to Captain Caldwell and the Quasi-Arc Company.

tions of electric welding to ship construction so far attempted in Great Britain. The two ships, sections of which are shown in Figs. 2 and 3, had a portion of the side plating—on one side of each vessel only—electrically welded. The other side of each ship was riveted in the usual manner. In one case, Figs. 4, 5, 6 and 7, the plating was worked on the clinker system; in the other, Figs. 8, 9, 10 and 11, on the raised and sunken system. Ordinary ship construction was followed in both cases, and although the sketches do not show the most curved portion, the curvature of the shell is very evident. The shape of the shell and the restricted space between it and the longitudinal bulkhead rendered the work extremely difficult, and under more straightforward conditions better results should be obtained.

The Clinker System.

Referring first to the clinker system, it will be noted (see Fig. 2) that the joint of the lapped edge is horizontal and made in the open by a continuous weld. Rivets with non-watertight spacing were worked and an intermittent weld applied to the lower edge. If well made, such a joint is quite as good and almost as cheap as a double-riveted lap. The joints of the bulkhead plates are made similarly. Attention is called to the bulb stiffeners at C C and to the joints at B B and A A as illustrative of the difficulties that arise in actual ship construction such as this.

In Fig. 4 the butts of the shell plating are indicated. The joints are between frames and the strap, which is 5½ in. wide, is worked on the inside, connected by rivets with non-watertight spacing, and the butt welded from the outside. Such a joint, if well made, is quite as strong as a double-riveted single-butt strap, is slightly cheaper, and remains watertight at greater loads—an important point often overlooked.

Fig. 5, page 254, shows a section through the bulkhead lap. It is of interest, as it somewhat resembles a shell plate joint at a frame.

The additional welded work necessary where a tapered liner is fitted in order that the bulkhead angle may pass fairly from one strake of shell plating to the other, is shown in Fig. 6. Similar work is shown in Fig. 7, where the bulkhead angle passes from one strake of bulkhead plating to another. While in these cases there is considerable difficult welding, such work is less likely to give trouble by leakage than ordinary riveted and caulked liners and joints. In this sketch it may be noted that in the connection of the bulkhead to the shell the boundary bar is fastened by rivets with non-watertight spacing, a continuous weld being worked along the keel and intermittent welds at the toes of the bar at the bulkhead and shell plating. This is a interesting comparison with American ideas in regard to right-angle connections. Incidentally, it may be added that the ordinary frames are riveted to the shell.

The Raised and Sunken System.

The remaining sketches show similar work on the second ship, plated on the raised and sunken system. Note, in Fig. 3, that, in addition to this difference, the bulkhead boundary bar has a continuous weld at the toe, both at the shell and the bulkhead. This work was done for comparison, but it is hoped that experience on service will show such extra work unnecessary.

Fig. 8 shows the riveted edges and butts. There is a continuous weld on the outside and inside of the laps, whereas in the other ship (Fig. 4) there was an intermittent weld on the inside. Further, on account of the strake being a raised one, the liner extends the whole width instead of tapering, so that additional welding is involved.

Fig. 9 shows the welding at a lap of bulkhead plating, and is similar to the work (see Fig. 5) on the clinker system ship.

Fig. 10 shows the bulkhead boundary bar, with its three continuous welds instead of one continuous weld at the heel and two intermittent welds at the toes, as shown in Fig. 7.

Fig. 11 shows the considerable welding where the boundary bar passes over the lap of the bulkhead plating and a raised strake of shell plating, necessitating two sets of liners.

Summary of Results Obtained.

The following interesting experience has been obtained from this work:—

In the case of the clinker system, where there was no overhead work on the outside of the ship, the plating was practically watertight on the first test; but in the other ship, on water-testing, the laps which had been overhead welded on the outside leaked, and difficulty was experienced in overcoming the leaks. In the case of sight leaks being discovered under test in compartments which have been caulked in the usual manner, the defects can generally be made good while the water remains in the compartment. In the case of welded work, however, it has been found that the presence of water makes welding practically impossible; so that, to remedy leaks by welding, it is necessary to empty the compartment. In the ship on the raised and sunken system the tests occupied a longer time than usual, and it is therefore proposed that with future welded work the tests preliminary to a final water test should be applied by air pressure. This would probably enable leaks to be detected and made good without delay.

It is expected that as experience is gained the results will be more satisfactory, but it is not anticipated that it will be practicable to apply welding to all parts of a ship's structure on account of the unreliability of overhead welding, and it does not seem likely that welding will entirely supersede riveting for non-watertight work—at any rate, not for some appreciable time.

The clinker system was shown to be decidedly superior to the raised and sunken system, and the advisability of welding up work at the early stages, when it was more accessible, was clearly demonstrated.

Conclusion.

Summing up: American and British practice differ in the following interesting points:—

Americans favour spot welding for bracket and such-like connections, while the British prefer riveting.

For right-angle watertight connections the American practice tends to heavy welding, the British to riveted angles, the rivets being widely spaced and backed up by lighter welding, or to notch angles with light intermittent welding.

For butts, notched or riveted straps with widely-spaced rivets and one run of heavy welding at the joint are preferred by the British instead of a strap lightly arc-welded to the plates with heavy welding at the joint, which appears the present tendency in America.

For plate-edge joints, British practice favours a riveted lap with widely-spaced rivets, while the American practice is to dispense with riveting entirely.

Finally, experience in Great Britain shows that at present arc welding should not be applied to mild steel plates of greater thickness than 25 lb., nor can it yet be used on galvanised or high-tensile steel; but the writer has heard of no such limits being imposed in this country.

New Zealand Railways.—A blue-book recently issued by the Hon. W. H. Herries, Minister of Railways, New Zealand, contains the following summary of the results of working for the year ended March 31, 1918, as compared with 1917:—

Particulars.	Year ended March 31. 1917.	1918.
Total miles open for traffic	2,970	2,993
Average miles open for year	2,970	2,977
Capital cost of opened and unopened lines	£ 38,187,173	£ 38,798,168
Capital cost of open lines	35,378,664	36,001,432
Capital cost per mile of open lines	11,912	12,029
Gross earnings	4,800,810	4,687,700
Working expenses	2,926,864	3,042,907
Net profit on working	1,873,946	1,644,793
Percentage of profit to capital invested	5·30	4·60
Percentage of working expenses to earnings	60·97	64·91
Earnings per average mile open	£ 1,619	£ 1,578
Working expenses per average mile open	987	1,023
Net earnings per average mile open	632	555
Earnings per train-mile	d. 125·75	d. 150·50
Working expenses per train-mile	76·63	97·54
Net earnings per train-mile	49·12	52·96
Passengers, ordinary	14,173,115	11,408,156
Season tickets	355,832	322,487
Goods tonnage	5,826,265	5,373,136
Live-stock tonnage	412,908	369,832
Train mileage	9,146,331	7,468,646
Locomotives	607	624
Passenger cars	1,480	1,488
Wagons and brake vans	22,380	22,517

The Allgemeine Elektricitäts Gesellschaft.—Although the war boom, with its excessive and steadily increasing profits, undoubtedly has for some time been declining in the case of a number of works, the Allgemeine Elektricitäts Gesellschaft has again beaten all previous records, with its earnings for the year 1917–18, although the report states that the prices for military contracts often were inadequate. The gross profits have been about tripled during the war, having risen from 22,651,669 marks in 1913–14 to 62,330,000 marks for the last financial year, the last increase being 15,540,000 marks. Taxes accounted for 5,000,000 marks, war aid for 15,290,000 marks, or about 5,000,000 marks more than the preceding year, and writings-off for 3,413,152 marks, against 1,100,255 marks for the previous year. The net profits, inclusive of sums carried forward from the previous year, have been as under for the last five years:—1913–14, 18,892,641 marks; 1914–15, 21,398,115 marks; 1915–16, 27,193,410 marks; 1916–17, 30,370,864 marks; 1917–18, 37,200,358 marks. The dividend for these years were respectively 10, 11, 12, 12, 12, and 14 per cent., the dividend for last year being paid on the increased capital of 200,000,000 marks. The holdings of bonds and stocks have increased from 64,720,000 marks to 90,970,000 marks, the balance at the banks from 214,350,000 marks to 236,760,000 marks, including those of the affiliated companies, and stocks figure at 53,570,000 marks, against 38,800,000 marks for the previous year. New installations, &c., were, to a great extent, defrayed from the current revenue of the year. The sale of aeroplanes was four times as large as during the previous year. The electro-steel and rolling mill, which, in the first instance, was based upon the company's own scrap, had come into operation during the year. Peace work within the proper domain of the company had been prepared, substitute materials of diverse kinds being employed with continuous good results in the face of the shortage of raw materials. The company's products had not been forced out from any accessible market.

THE OPTICAL SOCIETY.

A meeting of the Optical Society was held at the Imperial College of Science and Technology, South Kensington, S.W. 7, on Thursday, February 13, 1919, Professor F. J. Cheshire, C.B.E., president, in the chair. A paper by Lord Rayleigh, O.M., F.R.S., was presented on "*The Possible Disturbance of a Rangefinder by Atmospheric Refraction Due to the Motion of the Ship which Carries it.*" It was stated that the suggestion had been put forward that the action of a rangefinder, adjusted for a quiescent atmosphere may be liable to disturbance when employed upon a ship in motion, as a result of the variable densities in the air due to such motion and consequent refraction of the light. That this is *vera causa* must be admitted; but the question arises as to the direction and magnitude of the effect, and whether or not it would be negligible in practice. This question was treated mathematically in the paper.

This was followed by a paper on "*Deposits on Glass Surfaces in Instruments*," by L. C. Martin, D.I.C., Q.R.C.S., B.Sc., and Mrs. C. H. Griffiths, M.Sc. The first section of the paper contained a summary of the various phenomena that have been described under the name of "film." In instruments deposits occur most frequently on the graticules and a discussion is given as to the probable action of the lubricants in bringing about the formation of the deposit.

The qualities desirable in a lubricant to be used on optical instruments are also enumerated and a brief summary is made of the results of hitherto published information on the subject of the deposits. The second section gives a short classification of the deposits according to their microscopic appearance, and describes a series of experiments made to test the cause of the formation of the deposit. The experiments were conducted by means of brass cells, into which graticule blanks were fitted as windows, these glass surfaces being examined microscopically during the course of the experiments. By means of a series of these cells experiments were made to test the effect:—

(*a*) Of the method of cleaning the glass surfaces.
(*b*) Of the previous treatment of the surface.
(*c*) Of moist air and heat.
(*d*) Of lubricants.
(*e*) Of the kind of glass used.
(*f*) Of vapours from Bronsing solution.

The results obtained suggest: (1) That the method of cleaning the glass has not been shown to produce any difference in the rate of formation of the deposits.

(2) That glass surfaces which have been boiled in distilled water withstand the attack of moisture on the whole better than surfaces otherwise treated.

(3) That moisture will quickly produce disintegration of the surface, the action rapidly increasing with the temperatures, but that moisture alone has no effect in producing the globular deposit or film.

(4) That the globular deposits or "film" are associated with the presence of the lubricants in the cell and that according to the kind of lubricant enclosed in the cell marked differences are observable in the rate of formation and density of the deposits.

(5) That as between ordinary crown and L F glass no difference could be detected in the rate of formation for the globular deposits, and that H F, L F, B C, ordinary crown and optical plates show no detectable difference in the rate of commencement of disintegration. The result suggest that it is very desirable that optical instruments should be filled with dry air, and if possible made airtight. That great care should be taken in the choice of lubricants and that the boiling of the glass surfaces in distilled water is a point well worth considering.

A discussion followed the reading of these papers and the proceedings closed with a vote of thanks to the authors.

The London Iron and Steel Exchange.—In the unavoidable absence of Sir Albert Stanley, President of the Board of Trade, the new Iron and Steel Exchange, to which we referred on page 151 *ante*, was formally opened on Tuesday, the 11th inst. by Mr. W. C. Bridgeman, M.P., Parliamentary Secretary of the Board of Trade. Mr. J. Whitby, Chairman of the Board of Directors, introduced Mr. Bridgeman to the Exchange Mr. Bridgeman said the Board of Trade welcomed the formation of the Exchange because it appeared to them to be an admirable means of prosecuting business in the City of London, and would tend in the direction of a combination of forces in a very great national industry, and because also it tended to promote a collection of opinion which would be passed to the Government in a very simple and straightforward manner. While he was not in a position to speak of the proposals of the Government with regard to industry he could, however, say that so far as control was concerned, the Government were not desirous of keeping it going for a moment longer than was absolutely necessary. On behalf of Sir Albert Stanley he wished the Exchange every possible success. Mr. James Martin, Chairman of the London Chamber of Commerce also expressed the best wishes of the Chamber for the success of the Exchange and the hope that one day London would have a building of its own for a meeting place worthy of its commerce. Mr. Skelton proposed a vote of thanks to Mr. Bridgeman, and briefly referred to the difficulty which manufacturers and merchants had to face at the present time owing to the unsatisfactory conditions existing in the country. The vote of thanks was carried unanimously. Lord Desborough, Lord Avebury, the Directors of the Exchange and a large gathering of members attended the meeting.

INSTRUMENTS FOR THE MEASUREMENTS OF CLOUDS.

FIG. 1.

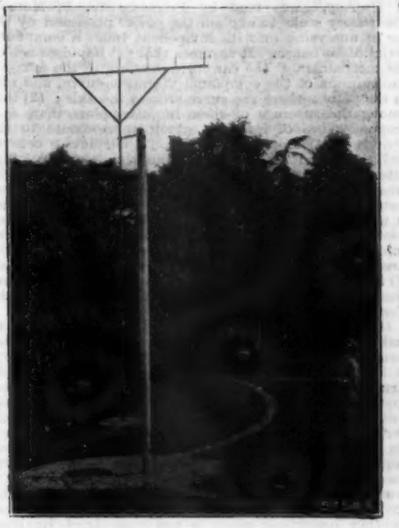


FIG. 2.

FIG. 3.

FIG. 4.

WHEN we watch the smoke columns issuing from two chimneys of different heights on the same factory site we sometimes notice that the two columns do not drift away in the same direction. That the air currents blow in different directions at different altitudes is by no means a rare occurrence; it is well known that the wind directions generally shift as we ascend in the air, and we need only look at the clouds to become aware of that fact. But until people began to fly, it was only the meteorologist who troubled about cloud movements. Then aeronauts became highly interested in wind directions and in cloud movements which serve as the weather vanes of the sky. The instruments used for observing the motions of clouds are known as nephoscopes, and when measurements of the degree of cloudiness are to be made with their aid they are styled nephometers.

The nephometer is simply a convex mirror, the surface of which is divided by lines into 10 sections; the relative area of the sky which is covered by clouds is determined by an observer in the way indicated in Fig. 1 on this page. In the Besson nephometer which, like the other instruments to be mentioned, is in use at the Montsouris Observatory, Paris, the mirror, a spherical calotte, made of glass, has a diameter of 30 cm. Looking through a tube the observer sees all the 10 equal divisions equally well except the sections 8, 9 and 10, which are partly obscured by his own shadow. After having made his estimate, he turns the mirror about its vertical axis through 180 deg.; sections 7, 5, 2 will now partly be obscured as 8, 9, 10 were before. The estimates of cloudiness are based on the scale that 0 means a perfectly serene sky and 10 a completely overclouded sky. One fact that these observations have brought out is that the cloudiness and the insolation registered by the heliograph are closely related to one another.

For the determination of cloud heights and their movements two theodolites may be fixed at the ends of a base line, and simultaneous observations be taken at two stations. There are also recording instruments in which the observer follows a point in a cloud or a pilot balloon by moving a telescope which records its own displacement on a card; these instruments are very complex and necessarily expensive. At meteorological stations simple nephoscopes are more in use. The Fineman nephoscope is a compass-box covered by a black mirror; the position of the magnetic needle is visible through a transparent glass window in the mirror. On the black surface are drawn three circles, one of 8 mm. diameter and two others 26·8 mm. apart; the windrose is further marked on the mirror. The rim of the compass can be turned; attached to it is a vertical rack and pinion bearing an eye-piece. When the nephoscope is to be used, the whole instrument, which is supported on a tripod, is turned so that the main diameter through the window coincides with the meridian and the eye-piece is raised until the respective cloud appears in the mirror. The observer then watches the time the cloud takes in crossing from one circle to the other.

This instrument suffices for rough observations. The new "herse néphoscopique" or comb nephoscope of Dr. Louis Besson, a pioneer in this field, admits of a higher accuracy. The comb instrument is illustrated in our Fig. 2. It consists essentially of an upright rod of brass, about 9 ft. in height, which is supported by a vertical post, and carries on its upper end a horizontal bar from which the comb of seven spikes rises. The cross-bar has a length of 3½ ft. The brass rod can rotate freely, and its height can be adjusted to bring a mark to level with the observer's eye. The observer places himself in such a position that the central spike appears on the cloud in question. Without changing his position he then turns the rod by means of cords in such a direction that the line of spikes falls in the line of motion of the cloud. This direction is afterwards read off on the graduated disc which turns with the rod, and the observer notes the time the cloud takes to pass from spike to spike. When the observation ground is fairly level, and the spacing of the spikes is one-tenth of the height of the bar, the time occupied in crossing this interval multiplied by 10 will give the time the cloud actually takes in traversing a horizontal distance equal to its own height above the ground. The altitude of the cloud may either be averaged from the type of cloud, or may especially be determined.

More exact measurement Besson effects with the help of a method due to Bravais; the devices are illustrated by Figs. 3 and 4, on this page. The essential parts are first, a plate of glass with parallel edges which is connected with a vertical, divided circle on which the inclination of the plate to the horizontal is read off. The second peculiar part is a pool of water which acts as black mirror. It is a little pond, out in the open in front of the station building and 11 m. below the window, in the frame of which the other instruments are mounted. The basin containing the water is made of blackened cement, and the pond has a depth of a few millimetres only, lest the wind should set up waves disturbing the reflection; the whole basin is surrounded by bushes which keep off the wind, moreover. The observer looks through a telescope and changes the inclination of the glass plate by means of the disc until the images of the respective cloud, formed on the glass plate and on the water surface, come to coincidence. From a table in front of him he sees at once the height of the cloud corresponding to the inclination of his plate. Photographic methods are also utilised for cloud observation.

THE GERMAN RAILWAYS.—From all accounts the rolling-stock of the German State Railways is in a deplorable condition, which applies both to the engines, the passenger carriages and the goods wagons, and the revenue is at the same time dwindling down. For November, 1918, the passenger traffic certainly showed an increase in receipts of 10,485,000 marks, compared with the same month of the previous year, but the rates had in the meantime been raised 10 per cent. The receipts from the goods traffic showed a decrease of 40,950,000 marks, or 24·61 per cent., compared with November, 1917, in spite of the rates in the meantime having been raised 15 per cent. As a result, the receipts were, on the whole, 30,465,000 marks, or 12·86 per cent. lower than for the corresponding month the previous year. Some minor receipts from other sources reduced the deficit, as compared with the same months the previous year, to 27,890,000 marks, or 10·49 per cent.

PHYSICAL SOCIETY OF LONDON.

At the meeting of the Physical Society of London, held on January 24, at the Imperial College of Science, Professor C. H. Lees, F.R.S., president, in the chair, a paper, entitled "*Notes on Lubrication*," was read by Principal S. Skinner.

Experiments on the pressure of air in the neighbourhood of a flywheel running in contact with a flat tangential board are described to exhibit the properties of a compressible lubricant. A comparison of the compressibilities and viscosities of the vegetable and mineral oils leads to the conclusion that the special property of "oiliness" is the physical property of incompressibility. In Note II. Worthington's experiments on the adhesion of two solids immersed in a stretched liquid are explained as an illustration of the phenomena of lubrication in a stretched liquid. In Note III the effect of glass beads &c., in promoting the free boiling of air-free water is explained by the occurrence of cavitation behind the moving beads, &c., the steam entering the cavities thus produced and dilating them into large bubbles.

Discussion.—Mr. T. C. Thomsen said that Principal Skinner's experiments were of great interest. It was a pity he had not been able to show his experiments with a glass bearing, in which the formation of cavity at the off side of the axle is clearly shown. The compressibility of fluids had been employed by Ferranti to convert air into a lubricant for very high-speed spindles rotating at about 30,000 or 40,000 per minute. At these high speeds the air is compressed, and a film is maintained between axle and bearing. He could not agree with the author's view that viscosity and compressibility were sufficient explanation of oiliness. Actual bearings are not perfect, and if the lubricant fails it will do so at certain isolated high spots. These are regions of extreme pressure, and he thought the increase of viscosity which was known to take place at high pressures was important. A research was at present in progress on viscosities under high pressures, and if it were found that animal and vegetable oils had greater increases with pressure than mineral oils it would go a long way to explain the effects. There was another point about oiliness. It had been found that among mineral oils the best lubricants were those with a large proportion of unsaturated hydrocarbons. It was thought that the more of these that were present the more intimately the oil would adhere to a metallic surface. Now some of the animal and vegetable oils were very largely composed of unsaturated constituents, so that this property of adherence to metallic surfaces might readily be greater in these cases. He thought compressibility was of negligible importance. It should be borne in mind that the theoretical work which the author had quoted, and to which the diagram referred, only applied to perfect lubrication, with nothing but fluid friction coming in. In practice, for this case, lubrication depended only on viscosity. It was when lubrication was only partial, with regions of metallic contact, that the property of oiliness came in. The question of cavitation could only come in at low and moderate pressures.

Captain Hyde said he was interested in the question from the point of view of aircraft engines. Personally he did not think oiliness was a distinct physical property, but that it depended on the action of the oil on metallic surfaces. As Mr. Thomsen had pointed out, the theories of lubrication mentioned by the author referred to pure fluid friction, and there were no experiments to show that in these circumstances there was any difference between mineral and non-mineral oils of given viscosity. In 99 per cent. of cases there was metallic contact, and that was when oiliness came in. Experiments by Mr. Deely seemed to indicate that the differences lay in the action on the metallic surface. It did not seem to him that the difference between the compressibilities of say, paraffin oil and rape oil would account for the difference in oiliness. Some experiments conducted at the National Physical Laboratory had revealed the curious fact that when working under severe conditions with imperfect lubrication there was, for the mineral oils a critical temperature of about 50 deg. or 60 deg. C., at which the lubrication broke down. No such temperature had yet been found with non-mineral oils.

Mr. C. R. Darling did not think the experiments described by Principal Skinner on delayed boiling disproved the old explanation of the phenomena. There was always a film of air on glass which was very difficult to remove, and which was not removed by boiling. When actual rubbing takes place, as in the experiment mentioned, some of this may easily be liberated. He suggested trying the experiment with surfaces of quenched quartz.

Dr. Borns, referring to the experiment in cavitation, asked whether Mr. Skinner had noticed a paper by Teoper, on the rupture of liquids between a rolling sphere and a plane plate, published in the "Annalen der Physik" last summer. Teoper put a drop of liquid on a plain glass plate and placed a lens on the liquid. When the lens was rocked about, the liquid gave way, a series of crescents being formed. Teoper examined these, and determined the critical velocity and stresses. A platinum wire would prevent delayed boiling. In this case the action must be rather on the lines suggested by Mr. Darling.

Mr. T. Smith said that the difference in oiliness had been said to come in when the film had broken down. What happened then? Did the liquid reunite?

Captain Hyde said he did not think it was known yet whether the better lubricant joined up quicker or not. In the case of pistons, he thought that even where you had "lubricated surfaces" there was never an actual oil film present. The lubrication was simply a condition of the surface.

Principal Skinner said it was not clear how Captain Hyde could be sure of his temperatures in the critical temperature experiments. In reply to Dr. Borns, he had seen Teoper's paper, but was reserving reference to it until a subsequent paper, which he hoped to present to the society.

A paper entitled "*On Sir Thomas Wrightson's Theory of Hearing*," was read by Professor W. B. Morton. The theory seeks to explain the power possessed by the ear of analysing into its component tones a compound aerial disturbance. It assumes that (1) impulses act on the mechanism of the ear corresponding to the maxima and minima of the compound vibration-curve, and also to the points where the curve crosses the axis; (2) that among the spacings of these impulse-points there is a preponderance of intervals which approximate to the periods of the component tones, their lower octaves and their combination tones, and that these spacings determine the sensations of the component tones. The present note is concerned with the second of these assumptions. Graphs are drawn which exhibit the way in which the distribution of impulse-points varies when relative intensities and phase relation of the component notes are changed. Difficulties are found in (1) the large number of other spacings presented to the ear, (2) the variations of the spacings with loudness-ratio and phase relation, (3) the fact that in a single pure tone the spacing is a quarter of the period of the vibration.

Discussion.—Professor Bayliss said he would like to make a mild protest against Professor Morton's statement that physiologists welcomed Wrightson's theory. It is really the anatomist who says that there is no structure in the ear capable of acting as a resonator, ignoring Helmholtz's demonstration that a membrane stretched unequally in different directions will resonate. Personally he saw no objection to the resonance theory. On Sir Thomas Wrightson's theory there were four impulse points per vibration. If you reduce the frequency of vibration far enough you cease to hear a sound and hear the separate vibrations. Why do you not notice four impulses per vibration in this case. Another important point is one that Lord Rayleigh raised. We can hear sounds up to 30,000 per second. Now from what we know of nerve fibres, they are completely inactive for at least a thousandth of a second after receiving an impulse so they cannot possibly record more than 1,000 separate impulses per second. Thus, on Wrightson's theory, all sounds requiring more than 1,000 impulse points per second should sound alike.

Principal Skinner was interested to hear Mr. Bayliss's opinion that the material of which the body is made is not acoustically the best. He had always had a difficulty in understanding how the cavity of the mouth could act as a resonator at all; the vibrations should be damped down so quickly.

Professor Bragg asked if it was not the case that a sound was recognisable if two or three consecutive vibrations were present. This would explain Mr. Skinner's difficulty, for even if the vibrations of speech were very rapidly damped out, there might still be sufficient of them to give the note its characteristics.

A paper, entitled "*Electrical Theorems in Connection with Parallel Cylindrical Conductors*," was read by Dr. A. Russell. Many problems in connection with parallel cylindrical conductors occur in practical electrical work. The formulæ for the capacity between the conductors and for the effective inductance are well known, but the values of the capacity and potential coefficients and of the inductance coefficients have not yet been determined. It is shown that for the case of a cylinder inside a cylindrical tube their values can in all cases be easily computed. When the cylinders are external to one another it is proved that the three capacity coefficients are connected by two very simple relations. Limiting values between which these coefficients must lie are found, and methods of obtaining closely approximate values in special cases are given.

Practically identical formulæ enable us to find the current density and the inductance coefficients with high-frequency currents, both for a cylinder inside a cylindrical tube and for two parallel cylinders. In the latter case it is shown that when the phase difference between the currents is less than 90 deg. the mechanical force between the cylinders is repulsive when they are close together and attractive when they are far apart. At a definite distance apart, therefore, the cylinders, when carrying high-frequency currents are in stable equilibrium. Since the potential coefficients can always be determined experimentally, it follows that the inductance coefficients for high-frequency currents, which are equal to them, are also found by the same experiments.

Discussion.—Dr. D. Owen said that in the first paragraph of the section on high-frequency currents, the author said: "We thus see—&c." He did not quite know the justification for this.

Mr. F. J. W. Whipple said it surprised him that the solutions to these problems had not all been already worked out. It appeared clear to him that one could write down the solutions in θ functions without much trouble. By so doing many difficulties might be got over since these functions were tabulated. Dr. Russell handled infinities rather familiarly, and he was not certain of the reliability of some of the solutions. Then he obtained a result for a thin wire and assumed it to hold for a thick one. One did not know how far the assumption was justified.

Dr. Russell, in reply, said the object of the paper was to obtain approximate solutions to clear the ground for a complete discussion of the problem.

Dr. Owen's point was explained in one of Kelvin's works, to which he would send him the reference.

The German Alkali Industry.—Owing to the increased difficulties in the matter of transport, the quantity of potash despatched during September has receded far below the figures of September, 1917, and the orders keep accumulating on an increasing scale.

CATALOGUES.

Aircraft Engines.—The Cosmos Engineering Company, Limited (formerly Brazil, Straker and Co.), Fishponds, Bristol, send one of the earliest "After War" engineering catalogues, dealing with two types of engine. These are the "Jupiter," of 450 h.p. to 500 h.p., with nine cylinders of 5½-in. bore and 7½-in. stroke. This engine in "No. 2 Series" has an epicyclic reduction gear giving a propeller speed of 1,300 r.p.m. The ungeared series weighs 662 lb. with all engine accessories and gun gear. The other type, the "Mercury," has 14 cylinders in two rings of seven, and is specially designed to meet a demand for a maximum overall diameter of 42 in., 41⅛ in. being actually attained. Both engines are, of course, of the radial air-cooled type. Of course, some reserve as to detail is still necessary, but the illustrations and particulars add something to our knowledge of war work.

Port of Preston.—The town Clerk of Preston, Mr. Alfred Howarth, sends a copy of a handbook issued by the Corporation, entitled "Tide Tables for 1919, with Information Relating to the Port." The tide tables are fully and clearly set out in large type, and the other information is exceptionally complete, written in a clear unpretentious style and illustrated lavishly and well. Very full details of the capacity and facilities of the port are given, with many illustrations and particulars of the mechanical equipment, which appears to be of the most recent and excellent character. The coloured maps are inset and marked with distances to inland towns and home and foreign seaports. The booklet, of 75 pages, is a most creditable production and a welcome proof that municipal enterprise is not quite so lame as it is too often represented. The corporation has already arranged to resume the work of deepening the river Ribble, which was suspended by the war.

Water-Tube Boilers.—A catalogue of exceptional interest and value comes from J. Samuel White and Co., Limited, of East Cowes, and 28, Victoria-street, S.W. 1, giving particulars and illustrations of their "White-Forster" water-tube boilers. These are mainly used on naval vessels where high-pressure steam is required rapidly, but also on river, pilot and life-saving boats. The boilers are of A-shape, with two water drums below, connected by multiple tubes with a central water and steam drum above. The material is entirely mild steel, no castings being used. Seventeen standard sizes of coal-fired boilers are made for pressures ranging from 120 lb. to 250 lb., and 13 oil-fired sizes for pressures from 185 lb. to 250 lb. The tube diameters range from 1 in. to 1¼ in. Hardly less interesting are the launch boilers, very small, with straight smoke tubes and comparatively large fire grates. These carry 100 lb. to 150 lb. pressure, the smallest being 25¼ in. in diameter and 40 in. long. Of these small boilers, some 17 variations of size and fitting are made. Great attention has been given to convenience in firing, cleaning and repairing. The makers take pride in the simplicity of their designs and put in the forefront of their catalogue a list of the occasions when failures of tubes are most likely to be expected. It is instructive to note that while British boiler makers are ahead of the world in the excellence of their work, they disdain all pretence of perfection, and point out all possibilities of failure with a frankness of detail that must appear strange to the vendors of some other kinds of wares. The catalogue is a model of straightforwardness in this respect, and is also remarkable for a generous supply of the most valuable technical information, given "without money and without price." This information includes curves plotted on evaporation and coal burnt per square foot of heating surface per hour with air pressure used; tables of calorific power of various coals, cokes and woods; tables and explanations of the properties of saturated and superheated steam; curves of specific heat and mean specific heat of steam at various temperatures and pressures; factors of evaporation; a mass of useful general data about fuel, water and steam, and a concise but fully detailed treatise on corrosion and methods of testing and prevention. The engineer will welcome this information, more especially as it is based on practical experience and practical forms of experiment. The major part of the catalogue, in fact, is taken up with matter which will be of great value for study and reference. The catalogue is well printed and bound in a strong handsome case.

The Austrian Iron Industry.—The position of the iron industry in the former Austro-Hungarian monarchy varies considerably in the different districts. The works in the German-Austrian parts, such as the Alpine Company, the steel works of Böhler Brothers and Co., the Ternitz Steel and Iron Works, the Schöller and Co. Iron Works and others are suffering from shortage of coal. Those in the Czecko-Slovakech district, such as the Prague Iron Industry Company, the Poldi Iron Works, the Witkowitz Mining and Iron Company, and the Austrian Mannesmann Tube Works, have coal, though not in adequate quantities, and manage to keep their concerns going. The question of iron ore, which is mostly obtained from Styria, is for these works a matter of the greatest importance. The sale of iron products is very limited, as building has not yet commenced, and the sale in other directions meets with many difficulties. The concerns temporarily occupied by the Poles, in Teschen, the Albert-Hahn Iron Works in Oderberg, and the Freistädt Steel and Iron Works, are certainly working, but the sale is slow. Trade with Eastern Galizia is cut off, and in Western Galizia there is hardly any demand. A better feeling has prevailed the last few days. The price for bar iron has recently been considerably raised on account of the higher cost of production.

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ELECTRICAL APPARATUS.,

121,304. J. C. Todman, Acton, T. L. R. Cooper, Ealing, and A. A. Lyon, Harrow. Brush Gear. (4 *Figs.*) September 13, 1917.—This invention relates to an improved brush gear for dynamos and motors. A brush-holder of the box form 1 has a support 2 on which is mounted a bridge-piece 3, the support being substantially parallel to the shaft of the machine, and each brush-holder being attached to a ring 4 by means of an insulating bush held against the support by the plate 6 and screw 7. Pivoted against the sides of the bridge-piece 3 is a lever 8, one end of which is provided with a pin immediately over the centre of the brush 10. This pin supports a spring 11 which bears upon the top of the brush. From the fork of the lever 8 an arm 12

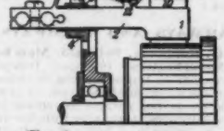
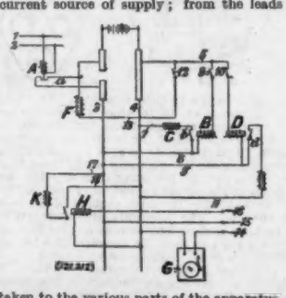


Fig.1.

Fig.2.

depends in a direction sloping towards and below the fulcrum, making the effective form of the lever substantially that of a bell crank. One end of the tension spring 13 is attached to this arm, the spring passing between the arms of the fork and within the central space in the bridge-piece. The far end of the spring is attached to a threaded pin 14, which passes through a hole in a support 15. A milled nut is employed upon the threaded pin 14 to adjust the tension of the spring. The relative positions of the points of attachment of the spring and pivot of the bell crank lever are so arranged that when the arm is raised from the brush through a suitable angle, it is locked in this position, enabling the brush to be easily removed. (*Accepted December* 30, 1918.)

121,312. C. C. Gow, Westminster, London. Maximum-Demand Controllers and Load Indicators. (4 *Figs.*) November 12, 1917.—In industrial installations using electric energy it is often important that the average demand for power during a given interval of time should not exceed a fixed maximum value. According to the present invention, an instrument is provided for operating an electrical plant which shows the rate at which the energy is being consumed at any time and whether that rate is more or less than a predetermined value, and in the former case gives a warning towards the close of the given interval of time, and if the warning is not heeded, automatically stops the supply when the maximum agreed demand of energy has been supplied, and prevents any further supply being taken until the period over which the average maximum demands is measured has expired, *i.e.*, until the instrument is reset. A is a coil connected to leads 1 and 2 of an alternating current supply, and is energised so long as those leads are "live." The coil A, when energised, closes a switch *a*, which connects leads 3 and 4 to a direct-current source of supply; from the leads 3 and 4



circuits are taken to the various parts of the apparatus. A relay coil B is inserted in a circuit branched from the leads 3 and 4 over conductors 5 and 6, and is energised from a clock over a contact 8 at regular intervals of time. Relay B, when energised, closes its contact *b*, and thereby energises over leads 6 and 7 an electromagnet C, which rotates a winding drum carrying a vertical tape through a given angular step at each contact. D is a relay connected to the leads 3 and 4 over leads 5 and 9, which is energised over a contact 10 whenever an integrating wattmeter records the consumption of a predetermined unit of electric energy. Relay D, by closing its contact *d*, energises over leads 9 and 11 an electromagnet E, which rotates a winding drum carrying a vertical tape through a given angular step at each contact. The tapes operated by the two drums are arranged side by side and carry indices, which are easily seen by the workmen operating the power units of the installation. F is an electromagnet re-setting the winding drums energised over leads 5 and 13 when a contact 12 is closed by the clock. This contact is closed at the expiration of each interval of time over which the average maximum demand is integrated. If during this time interval the tape operated by the power drum has reached nearly to the upper limit of its travel, contacts 14 and 15 are closed, which cause a warning bell G to ring. At the end of the travel of the power-driven tape, contacts 15 and 16 are closed, which energises a relay H. The relay H, when energised, closes over leads 17 and 18 the circuit of a trip coil K, which, in known manner, cuts off the supply of power and renders the leads 1 and 2 "dead." (*Accepted December* 30, 1918.)

121,320. H. Chitty, New Barnet. Commutators. (3 *Figs.*) December 5, 1917.—This invention relates to dynamo electric machines. According to the invention, the commutator is constructed of a circular series of radial sections or segments of a bridge or arch shape, each having a vertical face at the respective sides of the bridge or arch part, so that thus, when the radial sections or segments are assembled in a circular series, an annular bridge or arch is formed with lateral faces on each side in planes substantially perpendicular to the axis of rotation. The respective radial sections *a* of the commutator are provided at their lower ends with lateral extensions *b*, *c* on each side, which serve, respectively, to form two bosses, which laterally

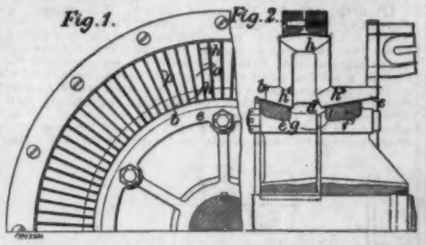
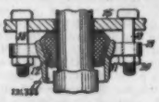


Fig.1.

Fig.2.

extend on each side, leaving an annular cavity *d*. The radial sections *a* are mounted upon a boss *e*, *f*, insulation *g* being interposed, while an insulating layer A, A^1, A^2 is interposed in radial planes between the lateral extensions *b*, *c*, and between the upper parts of each section, so as to leave between adjacent sections *a* open central spaces with narrow radial outlets *p* extending through the side walls of the bridge of the commutator, so that air entering through the boss *e*, *f* may pass centrally outward through the annular space *d*, thence escaping on one or both sides through the radial outlets *p* between the respective sections *a*. By this means the entire internal and external surfaces of the commutator are rendered effective in the dissipation of heat. (*Accepted December* 30, 1918.)

121,358. W. T. Henley's Telegraph Works Company, Limited, London, W. H. Nichols, Chesham Bois, and E. Moor, Gravesend. Electric Cable Grips. (9 *Figs.*) December 15, 1917.—This invention relates to electric cable grips such as are used for securing the sheathing or the armouring of a cable to electric apparatus. The improved electric cable grip of the present invention, comprises a gripping block formed of a rigid hollow shell of metal 11, circular in cross-section, lined with soft metal 12 and axially apertured and split so as to be



adapted for being halved about that annular layer of cable which is to be secured, and, if necessary, electrically bonded to the box 15, the shell 11 having a conoidal external surface; a gland 17 having a conoidal internal surface adapted to co-act with the conoidal external surface of the gripping block 11, and means 18, 19, 20 for enabling the gland 17 to be forcibly drawn over the gripping block in the direction of the box 15 so as to cause the gripping block to become clamped about said annular layer of the cable. (*Accepted December* 30, 1918.)

121,364. J. F. Poynter, Highbury, London. Magnetos. (3 *Figs.*) December 21, 1917.—This invention relates to magnetos of the type having a sleeve inductor rotating between the poles of a field magnet and a stationary armature. According to the present invention, a magneto is characterised by the combination with a stationary armature and a stationary field magnet, of a shield comprising a plurality of plates of magnetic material bent to U-shape, and so mounted that they move with one portion on each side of the armature between it and the field magnet, as, for example, by mounting the plates on a revolving hub or spindle. The armature 1 is mounted on a central hub or spindle 2.

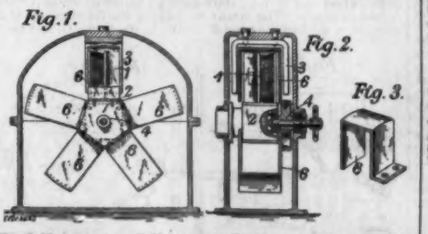


Fig.1.

Fig.2.

Fig.3.

The field magnet or field magnets 3 are mounted so that the armature 1 is disposed permanently in their field. On a spindle 4 are secured at equal angles a number of iron or steel plates 6, five being shown. These plates are bent to U-shape, as shown in Fig. 3, so as to pass between the armature 1 and the field magnet 3. In operation, the spindle 4 carrying the plates 6 is driven, and the plates pass consecutively between the armature 1 and the field magnets 3, thereby causing a succession of electric impulses to be generated in the armature coil, which by known means, may be made suitable for producing sparks or for other purposes. (*Accepted December* 30, 1918.)

121,346. The British Thomson-Houston Company, Limited, London, and F. W. Cooke, Rugby. Transformers. (2 *Figs.*) December 12, 1917.—The object of the invention is to provide a simple arrangement of terminals for electric transformers whereby fuses may be readily fitted in the high-tension circuit. According to the invention, the flange of the metal bushing into which the insulator for the high-tension terminal lead is usually secured by grouting is made interchangeable with a flange on the base of a bracket carrying two metal cups. Into one of these metal cups is secured by grouting, the lower end of the high-tension insulator, while into the other a similar insulator is secured. At the upper end of this second insulator is fitted a metal clip provided with a terminal connection, to which the usual external lead may be secured. A metal clip is also fitted on the upper end of the other high-tension insulator, and a fuse can be fitted into these clips so as to bridge the terminals. The bracket 1 is provided with a flanged base 2, which projects into the aperture 3 in the upper plate of the

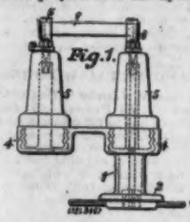


Fig.1.

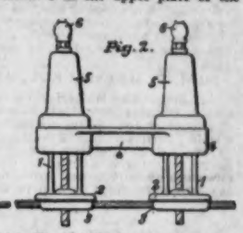


Fig.2.

transformer casing, into which the high-tension insulators are usually secured. The upper side of this bracket is provided with two cups 4, into which the high-tension insulators 5 are secured. These insulators are provided at their upper ends with clips 6 adapted to hold the ends of a fuse 7. (*Accepted December* 30 1918.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

121,410. R. W. Maudsley, Coventry, and The Standard Motor Company, Limited, Coventry. Internal-Combustion Engines. (3 *Figs.*) March 7, 1918.—This invention relates to valve-operating mechanism for internal-combustion engines of the type in which valves in the cylinder heads are actuated by rockers or levers mounted upon a common shaft and operated by tappet rods or the like. According to this invention, in means for lubricating valve-operating mechanism of the type referred to, there is combined with an oil-receiving conduit constituted by the rocker shaft, an upwardly-extending branch thereof, and an overflow pipe which communicates with the branch at a point above the level of the ducts in the rocker and returns excess lubricant to the oil sump. The rocker shaft A, which is of the stationary type, is carried by supports A^1 on the upper part of the engine B. The shaft A is hollow, and its interior provides a conduit for lubricating oil which enters at one end from the usual pressure supply by an oil pipe C. The other end of the conduit is closed by a plug. Mounted on the stationary shaft A are the rockers D, D, which are actuated

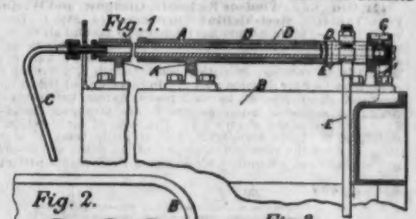


Fig.1.

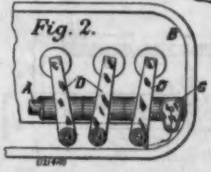


Fig.2.

Fig.3.

from the tappet rods E, and bear upon the end of the valve stem F. A duct D^1 is drilled in the rocker D to extend from the tappet actuated end to its pivotal bearing upon the rocker shaft. The end of the duct D^1 is downwardly directed into the cup E^1. A lateral outlet A^5 from the interior of the shaft A is provided to register with the inner end of the duct D^1. Upon the support A^1 for the end of the shaft A remote from the oil inlet is provided a chamber G, to constitute an upwardly-extending branch, which communicates with the oil conduit. This chamber G is situated at a level above that of the ducts D^1, and is provided with an overflow pipe (not shown in the drawing) to return excess oil to the oil sump. By this arrangement, whatever the pressure of delivery of oil to the conduit, the pressure of supply to the duct D^1 is limited to that due to the head of the oil in the chamber G relative to the oil ducts D^1. By this means excess delivery of oil to the tappets and consequent wastage is prevented, and the ducts D^1 may be of relatively large cross-sectional area, to minimise risk of obstruction therein. (*Accepted December* 30, 1918.)

121,422. Vickers, Limited, Westminster, London, and Sir J. McKechnie, Barrow-in-Furness. Crankshafts and Bearings. (2 *Figs.*) April 17, 1918.—This invention relates to crankshafts and their bearings. According to this invention, discs carrying the crank-pin or pins are mounted directly in journal bearings of the oil film or Michell type, comprising a series of separate spaced bearing blocks supporting the discs through a film of lubricant. A is the shaft. B, B are the crank-

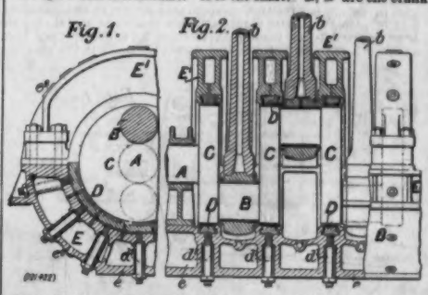


Fig.1.

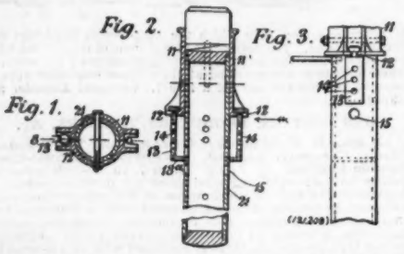
Fig.2.

pins. C, C are the bearing discs on the shaft. D, D are the bearing blocks of the Michell bearing. E is the casing of the bearing. The shaft A represents the shaft of a three-throw crank engine, in which a central piston works in opposition to a pair of side pistons. Three crank-pins B are shown, driven through the connecting rods *b*, and four bearing discs C are provided between, and at each side of, the crank-pins, the casing E

having four divisions upon a common base *e*. The bearing blocks D are pivotally supported at the back by the adjustable studs *d*1. The blocks D are therefore free to rock slightly around the ends of the studs to adapt themselves to the surfaces of the discs C. Oil is supplied at *e*2 to the casing E and the casing covers E1 which carry the upper bearing blocks, the blocks maintaining a coherent film of oil between them and the plain bearing surface of the discs. (*Accepted December* 30, 1918.)

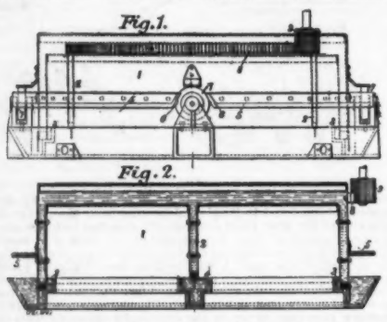
MINING, METALLURGY, AND METAL WORKING.

121,208. The Butterley Company, Limited, Butterley, and J. Bircumshaw, East Kirkby. Pit Props. (6 *Figs.*) December 29, 1917.—This invention relates to pit props in which a main prop has secured in the upper end thereof a sleeve adapted to hold a short subsidiary prop; the present invention consists in the provision of a device for or means of drawing the sleeve down the main prop and providing a cushion or wedges under the subsidiary prop, to help in withdrawing back props from



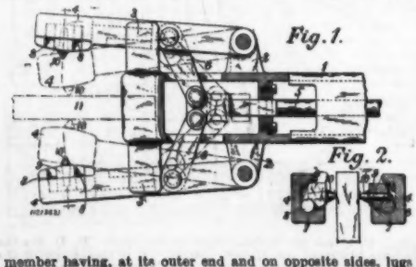
the goaf quickly and safely. There is provided upon any suitable part of the sleeve 11, such as at or near the bottom thereof, projections 12 to support hanger bolts 13, which hang downwards parallel with the axis of the prop. The hanger bolts have feet 13*a* to fit close up to the main part 21 of the prop, and are provided with holes 14 through which a lever may be passed whose inner end is placed within one of the holes 15 in the main prop, for the purpose of levering the sleeve downwards. (*Accepted December* 18, 1918.)

121,316. E. J. Windsor Richards, Glasgow, and W. Kane, Port Talbot. Steel-Melting Furnaces. (4 *Figs.*) December 3, 1917.—This invention has reference to gas and air reversing valves for steel-melting furnaces. The valve consists of an annular cylindrical chamber 1 having a division wall 2 and located in an annular, cylindrical water trough 3, provided with cross troughs 4 for division wall 2. In carrying out the improvements of this invention, inclined plane devices, preferably consisting of sectional radial flanges 5, are arranged round the circumference of the chamber 1. The ends of each section are angled at 6; the extremity of the one plane being at a short distance from the adjacent extremity of the plane at the end of the next section. Members for engaging these planes preferably



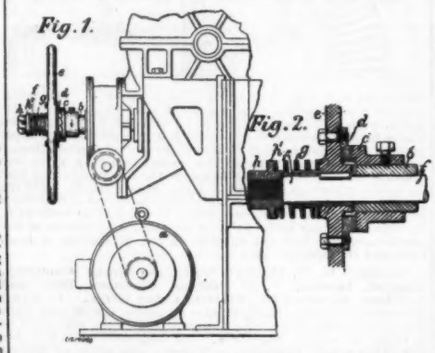
consist of anti-friction rollers 7 arranged between the two adjacent planes when the chamber 1 is in the "down" position; the planes 6 just resting on the rollers 7. When the chamber 1 is rotated, the planes 6 will rise up the rollers 7, and thus raise the chamber 1. When the chamber 1 is high enough, the division wall 2 clears the top edges of the cross-troughs 4, the lower or under surfaces of the radial flanges 5 rest on the rollers 7 and on the rotation being continued until the ends of the sections reach the rollers 7 the chamber 1 is lowered again to the down position. The means for rotating the chamber consist of a rack 8 formed round the circumference of the chamber 1 and adapted to be engaged by an elongated pinion 9. (*Accepted December* 30, 1918.)

121,363. J. S. Atkinson, Westminster, London, and Stein and Atkinson, Limited, Westminster, London. Manipulation of Blooms. (4 *Figs.*) December 19, 1917.—This invention has relation to apparatus for use in the manipulation of blooms, billets, ingots or other masses of metal (hereinafter referred to as ingots), in relation to appliances for their treatment, such as furnaces and rolling mills. 1 is the charging



member having, at its outer end and on opposite sides, lugs 2 and ears 3. 4 are gripping jaws each pivotally mounted between the lugs 2 and guided and supported intermediately by the ears 3. 5 is the operating member connected with the gripping jaws 4 by links 6. According to the direction of movement of the operating member 5, the outer ends of the jaws are caused to approach or recede from one another. The outer end and inner side of each jaw 4 is recessed or is of U-section (Fig. 2). These portions of the jaws are formed at their lower portions with bearings 7, which receive the ends of a spindle 8. To this spindle 8 is attached a block 9, which serves to carry a spud 10. The bearings 7 are such that the spindles 8 are parallel with the greater dimensions of the jaws 4, and the spuds 10 are mounted on the blocks 9 so as to be on the inner faces of the jaws and extend in an upward direction. When the outer ends of the jaws 4 are caused to approach one another, the spuds 10 engage the sides of the ingot 11, the spindles 8 moving in a rotary sense and in a direction such that the lower sides of the blocks 9 move out of contact with the lower parts of the jaws. When the member 1 is moved to lift the ingot 11, the load thus comes on the spuds 10, and is supported thereby; the load may cause rotative movement of the spindles 8 in the directions indicated by the arrows in Fig. 2, and which are opposite to those already mentioned, but whether it does so or not, the spuds 10 firmly grip the ingot 11, and the greater the weight the more firmly do they grip. (*Accepted December* 30, 1918.)

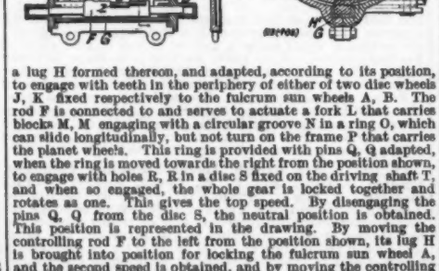
121,409. V. F. Turner, Canklow, Rotherham, and J. Walker, Tinsley, Sheffield. Electric Furnaces. (2 *Figs.*) March 6, 1918.—This invention relates to mechanism for regulating the electrodes of electric furnaces. The motion of the motor *a* is imparted to the hollow shaft *b*, and on the latter is secured a ratchet tooth clutch plate *c*, which co-operates with a similarly-formed plate *d* secured to a hand wheel *e* slidably mounted on a feathered shaft *f* passing through the hollow shaft *b*. A coiled spring *g* is introduced between the boss of the hand wheel *e* and a washer A1 formed on a nut A of the screwed end of the shaft *f*, by which means the tension of the said spring *g*



can be regulated as desired. The operation of the improved mechanism is as follows: When the movement of the electrode is unobstructed, the frictional contact between the two engaging faces of the clutch plates *c* and *d* (produced by the pressure of the coiled spring *g*) is sufficient to effect a continuous and regular transmission of the motor drive in the direction indicated by the arrow on the clutch plate *c*. Should, however, the electrode meet with any obstruction, the clutch plate *c* slides over the companion clutch plate *d* on the electrode operating shaft *f*, which shaft, and the hand wheel *e* and clutch plate *d*, of course, remains stationary, and in consequence no harm is done to the mechanism of the electrode gear. (*Accepted December* 30, 1918.)

MOTOR ROAD VEHICLES.

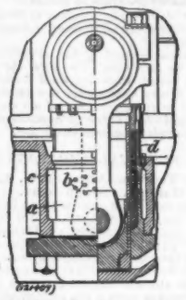
121,406. A. T. Collier, St. Albans. Change-Speed Gear. (2 *Figs.*) February 22, 1918.—This invention relates to change-speed gear using bevel gear wheels to provide three or more forward speeds, said gear being of the type in which the planet wheels are of substantially different diameters, and are fixed together and rotate on a common axis, the planet wheels being geared to independent sun wheels, either or any of which can be locked while the other or others is or are free to rotate, one of the planet wheels being permanently geared to the driving shaft, and a clutch being used to give solid drive. The two bevel fulcrum or sun wheels A, B respectively engage with the teeth of two bevel planet wheels C, D, which have substantially different diameters, said planet wheels being fixed together so as to turn as one wheel on the transverse axis E, which is fixed to the driven shaft U of the gear. The fulcrum sun wheels A, B are co-axial, but can rotate independently of each other, and they are provided with independent means for locking them, so that either wheel can be held stationary as required, while the other is free to rotate. The means for locking the fulcrum sun wheels consists of a controlling rod F sliding in the frame G, and having



a lug H formed thereon, and adapted, according to its position, to engage with teeth in the periphery of either of two disc wheels J, K fixed respectively to the fulcrum sun wheels A, B. The rod F is connected to and serves to actuate a fork L that carries blocks M, M engaging with a circular groove N in a ring O, which can slide longitudinally, but not turn on the frame P that carries the planet wheels. This ring is provided with pins Q, Q adapted, when the ring is moved towards the right from the position shown, to engage with holes R, R in a disc S fixed on the driving shaft T, and when so engaged, the whole gear is locked together and rotates as one. This gives the top speed. By disengaging the pins Q, Q from the disc S, the neutral position is obtained. This position is represented in the drawing. By moving the controlling rod F to the left from the position shown, its lug H is brought into position for locking the fulcrum sun wheel A, and the second speed is obtained, and by moving the controlling rod still further in the same direction, its lug H is caused first to unlock the fulcrum sun wheel A, and then to lock the fulcrum sun wheel B, thus giving the third speed; or the converse may be employed. The rod F is actuated by a lever Z. (*Accepted December* 30, 1918.)

PUMPS.

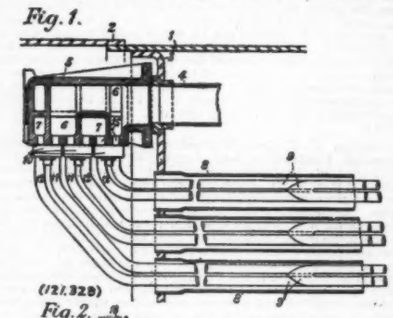
121,407. W. E. Savery, King's Norton, Birmingham. Pump Stuffing Boxes. (1 *Fig.*) March 2, 1918.—This invention relates to pump stuffing boxes. The invention comprises the arrangement of the stuffing-box in communication with a chamber or conduit connected to the condenser or air pump, so that any water leaking into the stuffing-box is returned to the water supply system. The stuffing-box *a* is perforated by an annular series of holes *b* disposed spirally around it. These holes open into a chamber *c*, by which the stuffing-box is sur-

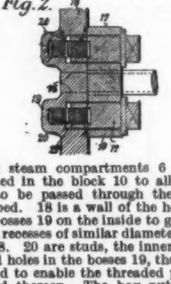


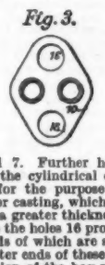
rounded. The chamber in turn communicates with the condenser. In addition to the usual packing *d* within the stuffing-box, a number of grooved and perforated metal rings are employed. Preferably these are separated by portions of the packing and situated in the most suitable portion of the stuffing-box. Any water escaping from the pump cylinder past the packing is drawn by the condenser vacuum through one or more of the metal rings and through the holes *b* into the chamber *c*, and finally into the condensing system. (*Accepted December* 30, 1918.)

RAILWAYS AND TRAMWAYS.

121,328. J. G. Robinson, Fairfield, Manchester. Locomotive Steam Superheaters. (8 *Figs.*) December 8, 1917.—This invention consists in improvements in steam superheaters for boilers of the smoke or fire-tube type. 1 is the locomotive boiler shell, 2 the smoke-box shell, 3 the smoke-box tube plate, and 4 the internal saturated steam pipe from the regulator to the superheater header casting 5, 6 being the saturated and 7 the superheated steam compartments of the header, which is of a known type. 8 are the smoke or fire tubes in which are placed the superheater elements 9. For securing the superheater element ends to, and in registration with, holes in the header, a flange block 10 is provided for each element, the inlet and outlet ends 11, 12, respectively, of which are expanded in holes in the block so as to ensure them registering with holes 15 provided in the header wall and leading into the saturated and super-







heated steam compartments 6 and 7. Further holes 16 are provided in the block 10 to allow the cylindrical ends of box nuts to be passed through them for the purpose hereinafter described. 18 is a wall of the header casting, which is provided with bosses 19 on the inside to give a greater thickness of metal. 23 are recesses of similar diameter to the holes 16 provided in the wall 18. 20 are studs, the inner ends of which are screwed into tapped holes in the bosses 19, the outer ends of these studs being screwed to enable the threaded portion of the box nut 17 to be screwed thereon. The box nuts are made cylindrical for the greater portion of their length so as to pass through the holes 16 in the block 10, and into the recesses 23 when screwed on the ends of the studs 20, collars being formed at the outer ends of the cylindrical portions to engage the block 10 for securing same tightly in position on the face of the header. (*Accepted December* 30, 1918.)

TEXTILE FIBRE FROM COMMON NETTLES.—Though the German nettle industry does not owe its origin to the war, the war has certainly promoted its development. That the nettle fibre is a good textile material, had long been recognised, but there was not much incentive for cultivating the common nettle. During the war this industry was taken up by the Nettle Cultivation Company, and it is said that the price of 10 marks per 100 kg. of air-dried nettle-stalks satisfies the growers. During 1915, 1,300,000 kg. of this raw material were collected, and the quantity was doubled, rising to 2,700,000 kg., in the year 1916. Nettle fabrics are considered in most respects as good as cotton fabrics, and as the nettle thrives on waste soil, of low value to the farmer, the nettle cultivation may spread.